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THE COMPARATIVE COST OF HYDROELECTRIC AND STEAM-ELECTRIC POWER.

In another column of this issue is printed an article of much interest by President A. C. Dunham, of the Hartford (Conn.) Electric Light Company, in which a somewhat extended comparison of costs is made between electricity generated by hydraulic and steam plants. The importance of sifting production costs to the bottom is so great an element in the lasting success of the central-station industry that the author's conclusions will be welcomed by every seeker after the truth. At first blush these conclusions appear decidedly adverse to the great majority of hydroelectric power projects. The point is made, and well made, that in the past altogether too much value has been set upon average power output from hydroelectric installations, and in striking language Mr. Dunham shows what an important part the steam-driven auxiliary is forced to play in practically all cases where the flow of water fluctuates through a wide range at different periods. The plants which are not handicapped by this condition are few and far between, and consequently the minimum power which can be counted upon is the critical factor in the situation wherever the load carried is continuous and of large commercial importance.

Readers of this article will find in it some new and valuable figures as to the unit cost of maintaining steam auxiliaries and the influence such equipments have upon the total yearly cost of production, including operation, maintenance and fixed charges. Thus, at the Tariffville station of the Hartford company the cost of operation per kw-hour, including maintenance, is only 0.124 cent, but the cost of supplying the deficiencies of the hydroelectric output by steam-driven machinery is 0.48 cent per kw-hour, making the total unit cost for the year covered 0.6 cent. It appears that hydroelectric power is exceedingly cheap when it is available, but in this case the minimum power developed in any one month, in spite of the use of a reservoir on the Farmington River at Otis, is so much less than the rated capacity of the plant that the installation cannot be inventoried on the books of the company at more than one-third the value given it by some appraisers. In this connection it is interesting to note that the cost of producing electrical energy at the company's turbine plant at Dutch Point, Hartford, reached 0.65 cent in 1910, showing that the steam-driven central station with modern equipment of high power has little to fear from hydroelectric competition except in localities where the cost of fuel is unduly high.

Other figures given for the Schaghticoke and Housatonic plants bear out the author's contentions that the cost of insurance represented by steam auxiliaries is of vital con-

sequence in such undertakings. Through modern invention the labor difference between hydroelectric and steam plant production has been almost obliterated. These facts have frequently been entirely overlooked in the establishment of hydroelectric enterprises, and have led to false conclusions, needlessly large investments in hydraulic equipment and unduly high total costs of production. Taken as a whole, the article brings out a side of hydroelectric development which ought to have been emphasized in many quarters long before this, and throws a wholesome light upon the question of steam reserve. We think that the discriminating reader, on the other hand, will be slow to condemn the opportunities of hydroelectric development on a proper engineering and financial basis, particularly in cases where due regard has been given to the question of storage, to the possibility of equalizing load and stream fluctuations, and to arranging for the supply of power in emergencies through reciprocal agreements with large users whose steam plants can be shut down in times of plentiful water. The popular notion that electricity can be generated from water-power at practically no expense is fast being dissipated, and sooner or later the value in many cases of hydroelectric service as a by-product to steam-produced electricity will become more generally recognized.

THE GREAT ONTARIO 110,000-VOLT TRANSMISSION SYSTEM.

There are two kinds of conservatism in electrical engineering design. According to the one, no departure is made from existing plans or equipments, although a careful selection may be made of the best that are available for the purpose. According to the other, no plan is adopted and no apparatus is obtained until its success can be assured beyond peradventure. The highly commendable conservatism of the engineers of the Ontario Hydro-Electric Power Commission is of the latter kind. Even the smallest details of the equipment were either directly designed for the service to be performed or the tests to which they were to be subjected before acceptance were carefully specified after a thorough investigation of the requirements and the limitations in manufacture. Thus, instead of adopting such insulators as the manufacturers offered for the transmission system, the engineers determined what conditions should be fulfilled, ascertained in advance how well equipped the several manufacturers were for improving on their existing types of insulators, and then formulated the mechanical and electrical tests to which the insulators to be purchased should be subjected. The result was the development of a suspension-type insulator capable of withstanding a mechanical stress of 8000 lb. and an emf of 220,000 volts when wet. It will be appreciated that the requirements were unusually severe for 110,000-volt circuits having moderate span lengths, and the cost proportionately high. However, the added margin of safety has proved well worth the cost in that there has been practically no interruption to the service in more than one year's operation.

In arranging for the suspension of the transmission lines no attempt was made to obtain symmetry, which is of negligible importance in comparison with convenience in mechanical disposition. As a result, the distances between the three wires of one circuit on a double-circuit tower have the three values of 96, 147 and 165 in. With conductors of 0.53 in. or 0.47 in. diameter, it would seem that the corona loss at voltages even much above 110,000 would not be excessive. In fact, the design throughout has been based on wide margins of safety, and the results obtained have justified the plan followed. On page 33 of the present issue is given an account of the admirable work of the Ontario Hydro-Electric Power Commission as a whole, and details relating to the erection of the transmission-line towers. The magnitude of the undertaking from the transmission point of view will be appreciated from the number of towers required, namely, 2295 standard double-circuit and 335 standard single-circuit units, 176 corner and long-span towers, 167 anchor towers and 106 special towers. The article should prove of much value to transmission engineers by reason of the description of the methods and of the reliable data relating to the cost of erection.

ARTIFICIAL REACTANCES FOR TURBO-ALTERNATORS.

Among recent developments in alternating-current operation in the larger central stations is the use of artificial reactances inserted in each line of large turbo-alternators, and close to the machines, in order to check the current and power rushes that might be occasioned by an accidental short-circuit. In the ordinary large alternator the *IR* ohmic drop of pressure at rated load current and unity power-factor is only about 2 per cent, which means that if the machine were kept under rated load excitation and short-circuit without any internal or external reactance the short-circuit current would be about fifty times rated load current. The internal reactance of such a machine is of two kinds. One is the inherent reactance of the armature considered as a mere choking coil. The other is the apparent reactance of the machine under normal working conditions, including the effect of armature reaction in demagnetizing the field system. This is called the synchronous reactance. The synchronous reactance may involve a voltage drop under rated load current of 25 per cent, which means that under steady short-circuit the current from the machine would not be more than four times rated strength. The inherent reactance is, on the other hand, much less and only about 2 per cent or 3 per cent, so that if the machine depends only on resistance and inherent reactance, as is known to be the case in the first few cycles following a short-circuit, the current may rise to more than twenty-five times the rated value and may carry with it about eight times the rated power. This gives a violent wrench to the system, both electrically and mechanically. In one case air-cored reactors of 6 per cent rated load drop were added at each terminal of a machine, thus bringing the inherent reactance up to about 8 per cent and limiting the short-circuit current to about thirteen times normal strength, with an accompanying torque of about 3.6 times normal. The reactances certainly limit the rush of power through short-circuits occurring beyond them. At the same time they take up a great deal of space and they tend to impair the inherent regulation of pressure in the alternators.

LOCATION OF LAMP-POSTS.

The trial of the best location for lamp-posts recently noted in these columns as carried out on one of the residence streets of Chicago is worth more than a passing notice because of the important bearing it has on the large amount of street-lighting construction which is now being considered for residence streets. This trial consisted, in brief, of locating tungsten lamp-posts about 10 ft. high 125 ft. apart along one curb line, and on another adjoining portion of the street locating the posts on opposite curbs 125 lineal feet of street apart. The trial was witnessed by eight electrical men, some of whom are well known in professional circles in Chicago, and by a number of business men residing in the district and interested in securing the best kind of lighting for their streets. The unanimous verdict of these gentlemen was that both in appearance and effectiveness in lighting the advantage was in favor of the posts all located on one side of the street. The two main reasons for this decision were, first, that the contrast between the illumination midway between lamps and near lamps was less pronounced and objectionable, and, second, that the more frequent spacing was more pleasing in appearance even though it was only on one side of the street. The street was of the ordinary width, about 80 ft. With the lamp-posts on the opposite side of the street from the observer the sidewalk was more satisfactorily lighted than with the alternated arrangement, because the lamps were at one side of the field of vision. Of course, this idea of lamp-posts on one side only upsets the time-honored gas-lighting practice of placing lamps on alternate sides of the street.

The facts brought out by this simple test have a bearing on several problems now up for solution. The coming of the tungsten lamp for street-lighting purposes, together with the improved lighting of business streets with lamps at frequent intervals on ornamental poles, has brought to the front the question of better lighting of residence streets. The lighting of such streets with lamps on iron standards supplied from underground conduits is being seriously considered at numerous places, and the first obstacle which offers itself is usually the cost of underground construction where the "staggered" system with posts on both sides of the street is employed. If the effect on the whole is really better with lamps on one side only, it is certainly worth knowing, particularly where the cost is limited, as it usually is in the case of residence streets. Of course, for streets where there is sufficient revenue available to place lamps at frequent intervals, of say 80 to 120 ft., on each side of the street, the double line of poles is preferable; but where appropriations are limited it is certainly well not to assume that posts on each side of the street are either necessary or best for the conditions.

DECAPITALIZATION OF PUBLIC UTILITIES.

The decapitalization of public utilities is a term used by some persons to apply to suggested provisions in public-service franchises obliging a company to pay during the life of a franchise a total sum sufficient to retire the securities by the end of the franchise term and leave the municipality in absolute ownership of the plant and equipment. Setting aside any discussion of the question of whether such ownership is desirable, it is interesting to study the practical effect of such a policy on rates. It is obvious that, in order to raise a fund sufficient to retire all the securities issued in payment for the property of a public-utility company, rates for service must necessarily be very much higher than they would be if the investment is to be considered practically a perpetual one. The advocates of the decapitalization plan point to the fact that municipal bonds are issued for pavements, bridges, sewers and other public improvements with the stipulation that they shall be retired at the end of a term of years. As a matter of fact, such bonds are often paid from the proceeds of new bonds, although this practice is not creditable. There are, however, certain differences between bridges, pavements and sewers constructed under municipal control and the systems of private companies transacting a public-utility business. In the first place, a public utility, such as an electric light or railway company, earns a definite revenue. It is not merely a general public convenience which must be built and maintained from public funds. A bridge for which city bonds are issued has a more or less definite life, and inasmuch as no depreciation fund is provided it is a business policy to pay for the bridge before it wears out. In the case of a large public utility, however, if proper depreciation funds are set aside and if the utility is maintained at a high and uniform standard, this value should not be lessened from year to year. If protected in the right to operate, such a company may be perpetually an earning and going concern. Of course, the important consideration is that the property as a whole shall not be allowed to depreciate. In the case of bonds issued for bridges and pavements which are to be paid within a few years, the municipality in effect is paying for these improvements on the instalment plan before they are worn out. If public-utility companies are to pay for their properties out of earnings so as to present them free of encumbrance to the city at the end of franchise periods, and if the property is to be maintained at a uniform and high standard of efficiency so as to serve the public properly, very high rates would be necessary during the terms of franchises. In other words, the community would be buying something for future generations. These are certain fundamental principles which it is well to bear in mind in discussions of this subject, whatever side of the question one chooses to take.

NATIONAL AND INTERNATIONAL STANDARDS FOR ELECTRICAL MACHINERY.

In a recent number of the London *Electrician* a fairly long abstract is printed of a paper on the above subject read by Dr. Robert Pohl before the Yorkshire local section of the Institution of Electrical Engineers in Great Britain. This paper contains a number of constructive criticisms on the English standardization rules. It points out that those rules are already partly obsolete, although issued only four years ago, and that a number of additions as well as amendments should be made to them. While admitting the desirability of having all new electrical engineering standardization rules adopted internationally, through the intervention of the I. E. C., yet it advocates certain rules for adoption nationally without delay. The standardization rules of any country have two principal purposes, namely,

first, to define the properties of electrical machinery and apparatus, as well as the tests by which those properties are properly determinable, and, second, to formulate the sizes, speeds, ratings and other properties of machines which shall conventionally be adopted as standard in manufacturing industry. The first purpose is to define in accordance with the principles of mechanics and physics. The second purpose is to facilitate and cheapen manufacture.

So far as engineering definitions are involved it is very important for all parties concerned that they should be strictly international. The definition, for instance, of what a direct-current shunt generator of 500-kw capacity and 550 volts potential difference should do when supplied for continuous service; what its descriptive terms mean; what specifications are optional and what implied; what tests it should stand, etc., are all matters in which the whole civilized world has a proper interest. The definitions should be such that not only are they clearly to be understood by equivalent renderings in the various national languages, but also that any electrical machine should have the same rating, definition and specification all over the world. The opposite proposition, which unfortunately holds more or less to-day—namely, that one and the same machine would have a different rating in different countries—is an international blemish and misfortune. In so far as concerns the second purpose of aiding manufacture by standardizing specific sizes and types, that is primarily a national question, and is international only secondarily. While it might be desirable for all countries to adopt the same standard sizes and ratings for manufacture, yet it is easy to conceive of conditions under which certain sizes or types of machines should be standardized in one country and other sizes or types in another country. Perhaps such a diversity of standards might be of mutual as well as of local advantage. Moreover, there is far greater difficulty in the way of standardizing than of specifying or defining from the international standpoint, because so much depends on the capital locally invested, which has rights of conservation. It would be generally desirable, for instance, to have one and the same alternating-current frequency adopted all over the world—say, 50 cycles per second—but to change the established frequency of any country is likely to be prohibitively expensive and beyond feasibility.

Consequently, the work of the International Electrotechnical Commission should be very useful and not very difficult so far as concerns the definition and specification of electrical machinery. The worst that can happen in adopting an international list of standard definitions on the rating and testing of machinery is that the shop and station practice of any one country may be somewhat disturbed, once for all, at the time of making the change. Nevertheless, in view of the comparatively close approximation existing between the various sets of national rules no serious disturbance would be likely to occur in arriving at a mutual agreement. The advantage to electrical engineering and to the world at large in arriving at such international agreement of definitions would far outweigh any such minor and temporary inconveniences. In regard, however, to manufacturing standards and sizes, it is not likely that their international unification would be found feasible to any great extent if attempted by the I. E. C., and no such attempt would be likely to succeed until all the work of international definition had been satisfactorily accomplished, a result that cannot be brought about for some years at least.

The paper discusses incisively a number of points. It shows that the overload capacity of machines in different countries differs materially. This question of overload capacity needs to be considered with especial attention from the international standpoint, because it is so fundamental. If, say, a 50-kw generator is required to have no overload capacity in one country, but must have 100 per cent continuous overload capacity in another country, then what is nominally a 50-kw machine in the latter case is virtually a 100-kw machine for the purpose of comparison. It is debatable whether any continuous overload capacity should be required in a machine. Most engineers agree that some temporary overload capacity should be expected; otherwise it would not be possible for a conservative station operator to work his machines at their full rated load, lest before he could introduce a new unit the load should have risen above the rated value. It is, however, one thing to make provision for carrying an accidental brief overload without injury and another thing to supply a margin of extra continuous load delivery. As regards temperature rise, the paper recommends that field coils should include in their windings a small wooden distance-piece or separator to admit of the insertion of a thermometer into the interior of the coils. It is also recommended that the room temperature of 35 deg. C. should be adopted, following German practice, to replace the 25 deg. C. standard room temperature now in vogue for England, the United States and other countries. There can be little doubt that more machines, all the world over, have to operate at room temperatures above than below 25 deg. C. Whether it would be desirable to take the room standard temperature as high as 35 deg. C. is a matter for debate. The standardization of sizes for manufacture is a matter that requires an agreement between manufacturers in order to make it effective. There can be no doubt that the saving effected by such standardization, both in labor and time of delivery, is very large. In a country like the United States, where the manufacture of electrical machinery is largely centralized, such agreements on standard sizes are relatively easy to reach. In other countries, where the manufacture is not concentrated, and where, moreover, designing engineers are accustomed to incorporate in their designs the latest technical advances, the difficulties in the way of selecting and maintaining standards of any kind are much greater.

ELECTRICAL GROWTH IN 1911.

FOR many years past it has been at this season the pleasant task of this journal to sum up in a statistical way the chief activities of the preceding twelve months. Necessarily such data are given as estimates, and as the field expands it becomes correspondingly difficult to present figures that can approximate closely the real facts in each department. Indeed, it becomes increasingly hazardous to

state just what the limits of any given field are. While telegraphy is absorbed at one end by telephony, wireless telegraphy extends into independence at the other end. Electric lighting systems supply energy for so many other purposes than illumination that even the president of the National Electric Light Association advocates the changing of the name of that body to something more generously inclusive. In the electric railway field the classification once satisfied with trolleys must be enlarged to include several trunk lines. Outside of these, come electric vehicle work, electrochemistry, electrometallurgy, and so much else that one wonders just what the limits are of the electrical technical and industrial domain, or whether one is not justified in setting up the postulate that there can be no limits.

It may be just as well to follow traditional lines for the present, especially in these days when it is so comforting to find a landmark that has not been moved, a system that has not been outworn or at least changed for something more stylish. No fault is found here with movement and improvement, for the electric current is the breath of modern progress. But it is always just as well to have standards of comparison, supplemented by fairly definite points of departure and arrival. These we get in some measure in figures of manufacturers' output, consumption of energy and earnings of public service companies, such as are given herewith in the following table:

	1910.	1911.
Electrical apparatus made	$300,000,000	$325,000,000
Electric railway earnings	520,000,000	575,000,000
Central station sale of energy, etc.	300,000,000	375,000,000
Telephone earnings	275,000,000	310,000,000
Telegraph earnings	65,000,000	75,000,000
Isolated plant service	100,000,000	125,000,000
Miscellaneous electric service	75,000,000	100,000,000
	$1,635,000,000	$1,885,000,000

It will be observed that this is about a 15 per cent increase over the whole field. Probably the estimate is correct, in spite of the fact that such a percentage seems high for what has undoubtedly been a rather dull, off year, when little business, not less than "big," has been checked in a season of depression. A curious confirmation of such a high rate of advance is to be found in two recent publications by Stone & Webster and Henry L. Doherty & Company, of an exceedingly interesting character. The former takes six properties in the electric railway field, and in four years up to Dec. 31, 1910, shows gains of 70 per cent in gross earnings, 166 per cent in dividends and 140 per cent in reserves and surplus. The other publication charts the gross and net earnings of electric railway, electric light and gas properties as compared with other industrials, and shows not only a general absence of disturbing effect on electricals from the panic and depressed periods of the last five years, but an upward trend of the curves that is almost startling in its persistent ascension. With all the finer ideals that now prevail as to the responsibility of public utilities and the greater desire to furnish better service, there is every reason to believe that in 1912 the electrical arts will be giving a service far in excess of $2,000,000,000, a fair profit on which will mean greater prosperity than the industry has ever enjoyed before.

PROGRESS OF ELECTRICAL SCIENCE.

ELECTRICAL science is naturally divided into the branches of pure and applied science, the latter branch differing from the former only in the fact that applied science has already entered into engineering adaptation, while pure science has not yet done so. In both branches distinct advance has been made during the year that has just closed. In pure electrical science we find that much attention has been devoted during the year to the isolation of individual electrons. An electron is supposed to be the smallest material thing that is, and, granting its existence, it is ultra-atomic in minuteness of dimensions, and, *a fortiori*, ultra-ultra-microscopic. Nevertheless, such progress has been made of late, particularly by Millikan, in dealing with electrons that an observer can claim to count them like sheep. That is, a very minute but yet microscopically visible particle of matter, in the non-electrified or neutral condition, has one behavior when floating in air, but a very different behavior when a single stray electron adheres to it. This method of research has proved prolific in its scientific ramifications, which interpenetrate many separate fields of experimental inquiry. The botanist Robert Brown discovered, in 1827, that microscopic particles suspended in solutions were frequently to be seen in rapid and irregular vibratory motion. At a later date these Brownian motions were explained as due to the rapidly succeeding impacts of neighboring molecules, occurring according to the kinetic theory of gases. Within the last year, with the aid of the electronic theory, the Brownian movements of air-suspended particles have been studied, with results in conformity with the kinetic theory, so that direct experimental evidence in support of that theory has at last been obtained.

Along similar experimental lines, results have also been obtained which support the chemical doctrine of molecules, and it is curious that such support should have been derived through the intermediation of the electronic hypothesis, which postulates the existence of matter in a condition much more minute than that of the molecule or atom. The Lorentz theory of the forces acting on moving electrons has gained ground in a manner which makes the doctrine of relativity a secondary consequence. This is a much easier sequence to follow than that of assuming the doctrine of relativity as fundamental and the behavior of moving matter as the result in secondary relation thereto. Progress has been recorded in the study and analysis of terrestrial magnetism and its variations. The results have pointed in the direction of solar influence in both cases.

The Carnegie Institution has accumulated and recently published a considerable amount of new observation on the earth's magnetic elements over a considerable ocean area of the globe. In the branch of applied electrical science the laws of the ionization of gases and especially of the air have received some elucidation as bearing on the corona effect around high-tension conductors. Progress has been made in the study of electric stresses in the dielectric of cabled conductors, and also in the heating of such cabled conductors under load. Notable advance has been made in

the application of hyperbolic functions to the laws of the propagation of electric currents in telegraphy and telephony, in practice as well as in theory. Among instruments for electrical measurements development has taken place in the silver voltameter as a coulombmeter of precision, and also in high-tension electrostatic voltmeters. While radiation is not usually classed as an electrical phenomenon, although strictly an electromagnetic wave action, yet so closely are incandescent lamps related to high-temperature radiation that no account of results in applied electric science for the year would be complete without reference to the researches reported in the radiant efficiency of luminous sources. Moreover, results have been reported in the direction of the energy relations of momentary luminous stimuli and the intensities of their perception by the eye. Steady progress has been made in the theory of oscillatory discharges and of Hertzian wave actions, especially as regards wave intensities at long ranges, although an immense amount yet remains to be unraveled in that fascinating field of electric science.

ELECTRICAL PROGRESS.

THE year 1911 will be notable in the annals of electrotechnical progress for a number of international actions and results, as well as for the events and developments in individual countries. The principal electrotechnical event, from the internatoinal viewpoint, has been the meeting of the International Electrotechnical Commission at Turin, and the resolutions enacted by that body, as duly chronicled and commented on in our own columns. Thanks to the International Electrotechnical Commission we now have an international symbolization of Ohm's law. From the point of view of the individual scientific investigator this is one of the greatest testimonials to the memory of Dr. Ohm that the minds of electrical workers could devise. The international unitary expression of the symbolic trinity $I = E/R$ constitutes, in the psychological sense, a greater tribute to the great German scientist than any marble monument, temple or pyramid in stone. The Turin meeting of the International Electrotechnical Commission also voted unanimously in favor of $R + jX$ as the complex representation of a reactance-coil impedance, and in favor of a counterclockwise order of phase-succession in regard to alternating-current vector diagrams. In a decision of this kind, where practice has differed, there must necessarily be some displeasure and discomfiture on the losing side, but the gain to the electrotechnical world as a whole is enormously greater, from an international judgment of this kind than the inconvenience to the losers in readjusting their habits of thought and expression. Henceforth we may hope to find only one type of complex algebra and only one type of vector geometry among alternating-current engineers, instead of two algebras and two geometries. The International Electrotechnical Commission Turin meeting also adopted in detail a list of international electrotechnical terms and a list of international algebraic symbols, besides initiating action toward the international rating of electrical machinery.

The next most important international electrotechnical event of the year was the convention of the International Electrotechnical Congress of Turin, where a fine collection of engineering papers was read and discussed, and where some important resolutions were noted, all of which were duly reported in our own pages. The American Institute of Electrical Engineers issued a new and enlarged edition of standardization rules during the year, indicating the recent rapid development of electrotechnics in various branches. Steady engineering development has been marked in the direction of high working voltages. The pressure of 110 kilovolts has been introduced into industrial three-phase service. With this rise of working pressure is necessarily associated a corresponding advance in insulation, in high-pressure technique and in control. To this step upward in available working voltage there pertains, of course, a certain potential increase in the commercially available range of electric transmission of power. Marked advance has also been made in the available knowledge of electric high-tension corona and corona losses, without which technical knowledge further increase in working voltage would necessarily be retarded. Considerable progress has also been made in the design, construction and control of alternating-current motors, of several types, as to starting, speed-control and power factor. Incidentally, this progress has also extended to the technology of the vector diagrams representing the behavior of such motors. The range of available machine-generated high frequencies has been increased up to 200,000 cycles per second, a limit that a few years ago would have seemed hopelessly beyond the reach of alternating-current generator design. Electrically driven rotor speeds have been pushed to higher limits, particularly in connection with gyrostatic marine compasses. In motors generally, and particularly in direct-current motors, there has been a marked development of the compensating or commutating-pole principle in standard sizes of machines.

DEVELOPMENTS IN ELECTRICAL MACHINERY.

A REVIEW of manufacturing practice during the past year discloses the fact that the changes made in apparatus have not involved any new principles, but instead have represented the application of principles long well known to the solution of problems that have been fully appreciated for many years. That is to say, former standard lines of machines have been redesigned in the light of information that has been available for more than a decade in many cases. It is noteworthy that not until very recently has the use of commutating poles in direct-current machinery become so common that their omission excites comment. The superiority of the commutating-pole over the non-commutating-pole direct-current machine was demonstrated many years ago, but adherence to standards has retarded the introduction of the commutating pole, except in those special cases where extreme difficulty was encountered in building a non-commutating-pole machine for the service requirements. Fortunately, a change of almost revolutionary character has

taken place, and many of the so-called standard lines of machines now possess commutating poles as a matter of course. Even the machine in which the commutation conditions were formerly considered ideal—the synchronous converter—is now being equipped with commutating poles, either for permitting the machine to carry enormous overloads without distress or for allowing an increase in the average emf between adjacent commutator segments and rendering possible the construction of converters for a commutator emf of from 1200 to 1500 volts.

The split-pole design of machine, which was first brought to the attention of American engineers in connection with the variable-ratio synchronous converter, is now being used to some extent abroad in three-wire direct-current machines. An additional brush or set of brushes is placed between the main terminal brushes, the added brushes being maintained at a desired potential intermediate between the potentials of the terminal brushes. The subdivision of the main voltage is determined by the relative strengths of the magnetic fields produced over the parts of the split poles. With equality in the subdivision the machine can be used as a generator in three-wire direct-current systems or as a self-contained motor-generator three-wire balancer. It can also be used as an auto-converter for receiving direct current at one voltage and delivering it at another, either constant or variable as desired. This machine possesses many characteristics which tend to render it a worthy competitor of machines now in use, and it deserves; and probably will receive, careful consideration by American engineers. Following the introduction of the suspension-type line insulator there has been a rapid increase in the standard transmission circuit emf from about 60,000 volts to 110,000 volts. Even at the latter value the line insulators gave no trouble, but the corona loss from the lines became appreciable and trouble developed at the transformer bushings and building entrances. Closer attention to the relation between the diameter of the conductor and the separation of the wires has reduced the tendency to produce corona, while extended investigations of electrostatic phenomena have resulted in much better insulation for entrance and transformer bushings. During the present year the maximum transmission emf has been elevated to 140,000 volts, with every assurance that the operation of the equipment will be quite as satisfactory as that of the 110,000-volt equipments when first introduced. In addition to the increase in the emf of transformers, a noteworthy development has been the spread of the use of the outdoor type of transformers, even in large units for very high voltage. Self-cooling units for 1000 kva, 110,000 volts, have been placed in service, while even larger units of the water-cooled type are being built at the present time.

ELECTRIC LIGHTING.

NOTHING of any sensational character has marked the progress of electric lighting during the year of 1911. The increase shown in the total amount of electric lighting has been upon the whole very satisfactory. In other words, from the central-station standpoint business has been good. Progress is being made in certain directions which may mean much to the art later, but of which the full bearing is not yet apparent. In arc lighting, in particular, it is pleasant to note the increasing use of the intensified arcs for all classes of lighting in which color discrimination is important. When the metallic-filament lamp first appeared, its light was obviously so much whiter than that ordinarily delivered by incandescent lamps that there was a tendency to use it very freely for lighting where delicate perception of colors was important. It was found, however, that, considerable as the improvement was, the result in such cases was far from being completely satisfactory. The light of metallic-filament lamps is about as much too yellow as the light of the old inclosed arc was too blue, neither being altogether desirable in view of the practical result. The intensified arc is meeting the difficult requirements admirably well, and also efficiently. At first rather troublesome in the matter of trimming, it has been so improved that the life of the carbons is reasonably good and the general operating results satisfactory. In shop lighting the intensified arc, therefore, has taken a considerably more prominent place during the last year than ever before.

In another entirely different direction of progress attention should be called to the work which has been done on long-burning flame arcs. The flame arc is chiefly used out-of-doors, or in very large inclosed spaces, and the chief limitation to its employment under conditions otherwise favorable has been the short life of the electrodes. Long-burning flame lamps have been in use to a limited extent for the past three years, yet it is only within the last twelve months that a determined effort has been made to exploit these lamps. At the present time they are available in at least half a dozen different forms, and the life of the electrodes has been increased until it now runs in general from 75 to 100 hours. Of course, such lamps are not quite so efficient as the best of the flame arcs burned more intensively, but they compare well with the earlier types in efficiency, and are, moreover, available for use with alternating currents. The flame lamp seems particularly adapted for alternating-current circuits, for the reason that inasmuch as the light comes chiefly from the arc stream, the absence of the light-giving crater of direct-current arc lamps is a matter of small consequence. Hence the alternating-curent flame lamps give relatively better efficiency than the alternating-current varieties of ordinary arcs, to say nothing of giving much higher absolute efficiency.

The weak point of the long-burning flame arc is unsteadiness, an objection which has not yet been fully overcome. Improvements in this particular are progressing, so that in spite of occasionally unsatisfactory performance there is an element of hopefulness in the situation. The danger in the development of these lamps is that there may be a constant temptation to sacrifice efficiency to long life of electrodes, precisely as in the case of some of the older arcs. If this temptation be resisted, the long-burning flame arc is probably destined to a very considerable usefulness. The problem of producing a powerful source of light combining long life and high efficiency

has also been rather successfully attacked in the quartz-mercury arc, which during the past year has just begun to make its appearance in this country, although for several years past used abroad. This lamp belongs as regards efficiency in the same class with the flame arcs. Its light is much whiter than that of the ordinary mercury arc, although still somewhat lacking in red, and is extremely steady. The quartz tubes have, according to foreign experience, a rather long life, reported to extend to 2000 hours or more, and the lamp furnishes a very useful source of powerful illumination.

In incandescent lamp practice the great change of the past year has been in the introduction of the drawn-wire tungsten filament. The very difficult problem of producing ductile tungsten seems now to have been successfully solved, and the resulting product greatly facilitates the making of lamps both of unusually large and also of unusually small candle-power; thus, drawn-wire lamps up to 500 watts and down to 15 watts for ordinary voltages have been produced. In how far, if at all, the drawn filament is superior in general life and possible efficiency to the ordinary sintered filament remains yet to be shown, as well as whether blackening of the bulb of the new lamp is a fault that can be overcome; but this much is clear, that the difficulties in transportation, and that extreme fragility which once made it so difficult to install tungsten lamps, have been overcome and there is good reason to hope for a considerable lessening of the dangers of accidental breakage during use. The production of this type of lamp has to all intents and purposes driven the tantalum lamp out of business, the latter being no longer produced in any quantity or exploited considerably in this country. The effect of the large candle-power metallic-filament lamps is being strongly felt. They make in many places very satisfactory substitutes for the arc lamps formerly used, at quite as good efficiency and very much less trouble. With the flame arcs, of course, they cannot compete in the cheap production of light. At the other end of the scale, reasonably durable lamps of less than 25 watts are being produced, just now only in small quantity. These are likely to find a considerable application in domestic lighting when they become more generally available commercially. At some outlets there is small need of a 20-cp unit, such as is furnished by the 25-watt metallic-filament lamp, and material economy is effected by cutting down the required power to 20 or 15 watts. It is too early, however, to state how satisfactory these small lamps for the ordinary standard voltages are going to prove in point of life, although the probabilities are favorable. The development of such lamps ought to decrease greatly the large number of inefficient carbon lamps which still remain in use.

THE CENTRAL-STATION SITUATION.

In central-station generating apparatus the most notable advance has been the increase in capacity of both steam-turbine and boiler units. Steam-turbine units of 20,000-kw rating, which have become an accomplished fact during the year, are four times the size of the largest generating units seriously considered ten years ago. Along with the development of these large generating units has come the use of reactances between generator and busbar for the purpose of limiting the current which can flow in case of short-circuit. The amount of energy stored in the revolving mass of turbine high-speed units and their large kilowatt output make possible such an amount of damage from short-circuits and so much general disturbance of a large distribution system that some protection has been found necessary. Incidentally, this reactance has been taken advantage of to make the generator voltage differ from the transmission voltage, so that each voltage may be that most convenient and economical from both the construction and operation standpoints. Even more notable than the increase in turbine-generator capacity has been the increase in boiler capacity. For a number of years generators increased much more rapidly in size than boilers, and it has been one of the nice problems of design to get a sufficient boiler capacity into a power house within reasonably short piping distance of the turbine which it supplies. Recently boilers of capacity sufficient to supply 11,000 kw in large steam turbines have been tried out in one plant at least with important improvement in efficiency. In this connection it is proper to note the greatly increased output per square foot of heating surface which has become common in large central-station boiler plants as compared with the practice of ten or twenty years ago. Evaporation of from 2 lb. to 4 lb. of water per square foot of heating surface per hour has given place to the practice of evaporating 6 lb. to 7 lb. At the same time the amount of fuel consumed per unit of grate has been greatly increased, partly by the increase in evaporation per unit of heating surface just referred to and partly by an increase in the ratio of heating to grate surface. Roughly, the square feet of heating surface per square foot of grate has been doubled, in modern practice being in the neighborhood of 60. The net result is that it is common practice to burn about four times as much coal per unit of grate area as was former practice. These figures are, of course, only rough approximations, as practice in different plants varies greatly.

In the distribution end of the business the tungsten lamp with continuous wire filament has nearly replaced all others on the market within the last year. For the first time since the introduction of the tungsten lamp it begins to look as if the carbon lamp would be driven from the field except for places where danger of breakage and theft is too great to justify the use of the tungsten lamp. The small sizes of wire-filament tungsten lamps—25-watt and 15-watt—have not been on the market long enough to demonstrate whether some of the fears expressed as to reduction of central-station revenue by their use in residences will be realized. In the majority of cities there is so much opportunity for increase of residence business, and this increase is following so rapidly as a result of cheaper light, that there appears to be no ground for fear of reduction of central-station residence-lighting revenue by the use of these lamps of low wattage, except in places where the central-station management is so inert that no additional business is being secured. Even there it is doubtful whether the ever increasing demand for more light will not counteract the effect of the lamps of small candle-power. In any event, central sta-

tions should not abandon the attempt to establish the 40-watt unit as the standard. In street lighting the luminous arcs of the magnetite type have continued to displace both the old open and inclosed carbon arcs. In some cases also tungsten lamps of the same or smaller watts consumption are being substituted for inclosed carbon arc lamps to the benefit of both the central station and the public. A 250-watt series tungsten lamp is a more satisfactory street illuminant than a 400-watt 6.6-amp inclosed carbon arc, both in quantity of illumination and in steadiness and quality of light.

The most important new street-lighting development of the last year has been the introduction of the flame arc with impregnated carbon capable of operating about 100 hours on one trim. These lamps are naturally a compromise between the very high efficiency of the short-hour flame arcs and the lower efficiency of the luminous or magnetite arcs burning over 100 hours per trim. They are adapted to operation on alternating-current circuits and on account of their high efficiency mark another important advance in American street lighting. One of the events of the year that have caused rejoicing in central-station circles is the reduction in prices of watt-hour meters for serving small residence consumers. On watt-hour meters of the induction two-wire, 110-volt, 5-amp type, such as are used principally for this class of business, the reduction in prices during 1911 has been about 33 per cent. This has, of course, meant a substantial reduction in the investment necessary to serve small residence consumers and thus will tend to greater enlargement of this class of business.

Among consumers' appliances there has been the usual steady increase in the number of electric irons, vacuum cleaners and miscellaneous heating appliances. Among the new developments of the year chief interest has centered about the principle of heat conservation and storage for use in electric cooking and water heating, whereby electrical energy can be utilized continuously either twenty-four hours per day or during off-peak periods for use in cooking. Continuously connected ranges are being tried by a few central stations, and manufacturers are giving much study and research to developments which appear to offer a promising solution of the electric cooking problem. The success of these devices must depend on efficient storage of the heat generated and rapidity in giving it up when needed. As to the more commonly used electrically heated appliances, there are rumors of reduction in prices for the near future which are both disquieting to the manufacturer and encouraging to the central-station owner. In the field of central-station public relations several new state commissions have been put in working order and more are talked of. There is unquestionably a country-wide movement toward the commission idea and toward making electric and other public-service companies regulated and protected monopolies. The effect of this will doubtless be to make central-station investments more secure and at the same time will limit some of the opportunities for excessive profits by promoters. Just how far the profits of those taking the risk of the business are to be restricted by rate-regulating commissions is naturally a matter of considerable interest now among those engaged in these enterprises. In the long run fair play must prevail, not only because the majority of men believe in it, but also because capital will not assume risk without proportionate profits. The number of central stations under syndicate control is constantly on the increase. The fundamental economic reason at the bottom of this movement is that of more efficient management than can be secured by local capitalists unfamiliar with the business in a broad way.

The general condition of the industry is well reflected by the active interest in the National Electric Light Association, the membership of which passed the 10,000 mark late in 1911. This membership has been mainly attained by the enlistment of the interest of the employees of central stations, and it is encouraging as indicating the enterprising character of the electric-lighting personnel. None but a live and progressive industry could make such a remarkable showing.

THE SMALL CENTRAL STATION.

OF the 6300 central stations in North America 85 per cent serve communities of less than 5000 population. This fact is always quite interesting enough to be worth re-statement when the small central station is to be discussed, for it shows that in the broad central-station field big systems like those of the Commonwealth Edison Company or the famous Hartford plant are, after all, the rare exceptions to the general rule. Often single-handed and alone, the central-station manager in the small community must play many parts, including in the activities of a single individual the rôles of manager, superintendent, troubleman, repairman, meter reader, bookkeeper, collector, and not rarely engineer and fireman. In such localities the "electric-light man" is almost a public official and a popular hero, as well he deserves to be when the exigencies of his calling, both electrical and commercial, are considered. In the small town, as in larger places, the electric company is invariably the progressive spirit of the community. Its store front indulges in a few extra lamps, and so raises the standard of illumination of the main street. In such places, too, not contenting itself with the regular street lighting, the enterprising company undertakes to get a "white-way" installation put in, at the cost of the town or of merchants who benefit. If paid for by the latter, the company will do well to leave the actual collection of assessments to a local committee, thereby saving itself much effort and heart-lashing. Many towns of 1800 population and up have installed ornamental post lighting creditably and with much pride to their residents. The small plant has not recovered from the tungsten setback as rapidly as stations in the larger places, where, of course, the standard of lighting mounts more rapidly and the normal growth is faster. In partial compensation, however, it must be added that not even yet has the tungsten lamp reached the remoter small places for general use, so the local plants are still enjoying the high consumption of carbon units. The reduction in the price of meters announced a year ago has helped many small stations to put their service on

a registered basis, bringing the cost of the recording mechanism down to a value where the company can afford to purchase, or to ask its customers to rent or buy, meters. The expected movement in favor of flat-rate controllers seems not to have reached the proportions during 1911 that were expected by the more sanguine. Experience seems to indicate that the flat-rate controller is best adapted to the small plant when investment and labor charges are high and fuel cost makes up but a small part of the whole. Uncontrolled flat rates still offer satisfactory terms for sign and display lighting where this service is under the central station's inspection. But with a metered rate the small town needs a simple schedule and one easily understood by customers. The service to various customers in such a community will not differ so much but that an equitable balance can be established by a rate of very simple elements. A system of accounting for the small plant following some accepted uniform system will also be found of the greatest value in comparing operating costs and results, and through public service commissions this desideratum is now being gradually supplied, though with an accompanying burden of monthly and yearly reports which falls heavily on the manager of the small central station not accustomed to systematic accounting.

The progressive manager will not be slow to get after miscellaneous large and small motor applications in the shops around town. Where there is a gas engine at work a motor can always be substituted to mutual satisfaction of customer and station. Nor should the power campaign cease at the doors of the town's large industries, even if these are driven by isolated power plants. The advantages of group and individual motor drive will win even such desirable customers for the central station. Municipal water pumping is one of the most desirable loads for the small central station on account of its long-hour demand, dependability and profitable nature, and every effort should be made to get this service. For the town of 5000 a respectable electric-vehicle load is not out of the question. Half-a-dozen pleasure cars are not beyond the possibilities of the usual number of comfortably "well off" in such a community, and if there is a local industry or two, they should be encouraged to make use of electric trucks. With the town field saturated, the local central station can turn its energies to the outlying farming region, extending its lines to take on the lighting of farmhouses, barns and yards, and the motor drive of farm machinery. Even if some of this business is carried on the narowest margin of profit, ample reward will be returned from the uplift enjoyed by the whole community.

In electrical generation and reduction of power-plant costs there is much encouragement for the little central station. While small turbo-generator sets, primarily intended for excitation use, have been applied as small prime movers, the greatest expectations just now are in reciprocating-engine types of remarkable efficiency. A European poppet-valve steam engine now built in this country in small sizes has been making some excellent economy records, but even these are shaded by reports from across the water where self-contained 150-hp locomobile units are producing a hp-hour on 0.71 lb. of coal. In these latter plants boiler and engine are combined, giving short steam travels and reducing radiation losses so that the remarkable efficiencies stated are secured. The Diesel engine, which now is available in small sizes, offers the highest thermal efficiency of any known prime mover, and with its recent and proposed modifications to meet American practice is sure to become more and more popular as a plant engine. Internal-combustion engines operating on both natural and producer gas are also advancing in reliability and simplicity of operation. The gas-engine-driven set has been adapted for tiny central-station communities requiring as little as 25 hp of generating capacity. Nor is the ordinary steam equipment to be dismissed as of low commercial efficiency, especially when used in connection with an ice-making plant. The condensed steam furnishes the distilled water of ice-making, the refrigeration being produced by power-driven compressors or the heat of the exhaust steam. Raw-water ice plants are now also marketed, the compressors of which can be driven, of course, by any form of power. Three hundred central stations now make ice, and most of those interviewed report that in point of profit it is electricity that has really become their by-product. As this knowledge spreads, more stations will certainly take up such combination operation.

ELECTRIC-POWER TRANSMISSION.

THE year just gone has in no wise been an important one in power transmission, save for the usual increase in the number of useful plants which operate under normal conditions, such plants, for example, as the excellent Calgary installation which we have recently described; but despite these useful commercial enterprises there has been nothing in the least sensational accomplished during the twelvemonth. The limit of voltage has not been raised and no extraordinarily long or large transmissions have been put into service. On the whole, the most important single event from the standpoint of future progress was the installation and test of the great Detroit boilers on which we commented somewhat extensively a few weeks since. This was really an event of prime importance, especially with respect to the distribution of power from coal burning at the mines, a project often considered but seldom executed. A thoroughly modern power station, say of 100,000 kw, using these colossal boilers and turbo-generators of commensurate capacity, would quite certainly be able to turn out power at a figure materially less than anything which has yet been reached in the generation of electrical energy by steam. A station containing, say, half a dozen big units, each with its own pair of boilers, could be made exceedingly simple in design and could be built for an astonishingly small amount of money per kilowatt. Such a station feeding the distribution at somewhere from 50,000 to 100,000 volts, as conditions might dictate, would make a new record for central-station practice.

Several interesting projects for hydroelectric systems are on foot, involving the linking together of a considerable group of relatively small powers, but none of them has yet reached the constructional stage. Full advantage has

not been taken of the many small powers which are in existence. We recently noted the extent to which they have been employed in France, even under somewhat unfavorable circumstances, although even there the principle of combining them into networks, as in North Italy, has not been carried out. Ten or a dozen powers even of only a few hundred horse-power each are not to be despised when assembled into a single dynamical unit by means of a ring main or similar connection. Experience has taught that plants so united may be operated together with the utmost facility; and while the labor item is higher than in the case of a single plant, each unit may still be economically handled, and perhaps the aggregate troubles on the system would be reduced rather than increased by the multiplicity of generating stations. We hope to see some of these schemes carried out in the near future. In matters of operation there have been few recent changes, but we have noted rather less trouble from lightning than has been usual, and it looks as if the new types of lightning arresters and the increasing use of grounded guard wires have brought some relief from the customary difficulties due to this cause. Altogether the past year, despite its lack of striking novelties, has been a successful one in which power transmission has flourished, giving promise of steady and continuing growth.

THE ELECTRIC RAILWAY.

AMONG the features that have been characteristic of the developments in electric-railway engineering during the year just past perhaps the most prominent has been the healthy departure from long-established standards. Even where the city system of 600-volt direct-current railway circuits is employed changes have been made in the equipment, especially with reference to the motors. The advantages attending the use of commutating poles have been known for many years, but only very recently have the advocates of 600-volt equipments been willing to introduce this desirable feature in their standard lines of motors. With the prospect ever increasing of using 1200-volt circuits for interurban service, the time appears at hand for a change from the present standard type of strict-railway motor suitable only for 600-volt operation to much improved commutating-pole motors which can operate equally well upon 1200-volt and upon 600-volt circuits. The trend of progress at the present time is certainly in this direction. Changes in standards are to be noted not only in America, but in Europe also. A recent compilation noted in the *Digest* showed that of the 118 European interurban railways less than one-half (fifty-eight) employ direct-current circuits at an emf lower than 1000 volts, one-third (thirty-nine) use single-phase, one-eighth (sixteen) use direct current at from 1000 to 2000 volts, the remaining five railways being three-phase lines. High-voltage direct-current systems are in service in Germany, Italy, Switzerland, France and Holland. Single-phase systems are used in not only these countries, but also in Austria-Hungary, England, Norway and Spain. Sweden and Belgium are the only countries in which standard low-voltage direct-current interurban systems are employed exclusively, the former having two and the latter one. Three-phase equipments are used in Switzerland, Italy and Spain. It would be difficult to determine which railways in America should be called interurban and which urban, so that it would be unwise to state the proportion of roads that have broken away from former standards; but it may be of interest to record at this time that at least ten roads have adopted the high-voltage direct-current system and sixteen the single-phase system.

Of more than ordinary interest is the announcement just made that the New York, New Haven & Hartford Railroad will extend its single-phase zone from Stamford to New Haven. The decision to substitute electric for steam haulage over the road beyond Stamford has been based on the highly successful operation of the single-phase equipment now in service between New York and Stamford, along a portion of which route the operation is handicapped somewhat by the use of the third-rail direct-current contactor system. With the present run of 34 miles to Stamford and the added length of 41 miles to New Haven, the electric locomotives will have a total effective travel of 75 miles under heavy steam railroad conditions carrying both freight and passengers. The success of the operation of the equipment as a whole can safely be predicted. With this success demonstrated, the claim that the electric locomotive is suitable for replacing the steam locomotive only for terminal and switching service will lose the weight it may now have in the minds of steam-railroad engineers and administrative officials. In fairness to the electric locomotives it should be noted that only when these locomotives are employed not only over a whole steam locomotive zone, but over the much extended zone that an electric locomotive can cover most economically, and are permitted to operate without the handicap of connection with two different types of contactor system, will the full advantage of the substitution of electric for steam locomotives in trunk-line service be obtained.

THE ELECTRIC VEHICLE.

THE continued expansion of electric-vehicle applications during the past year and the splendid outlook shown in this field for 1912 mark a rising tide of central-station opportunity which offers larger revenue and improved operating efficiency to every company occupying territory physically fit for this type of transportation. In both the pleasure and commercial-vehicle branches the electric automobile industry is coming to its own, and the discouragements of the earlier days are being forever dispelled by the success with which the modern designs are being utilized in a service of world-wide scope. The weak points of former equipments are largely eliminated; expert engineering skill is being applied with specialized knowledge of field requirements to the production, sale and operative oversight of both pleasure and business cars, and more and more is the public being impressed with the advantages of electric vehicles for flexible, reliable and economical short-haul service. The success of the pleasure

car in city and suburban service is being recognized everywhere. In most of the larger cities it is in such common use that it no longer attracts attention. In some communities, of which Denver is a striking example, pleasure cars of the electric type are owned by about one in every 200 persons, and the multiplication of these machines in both the shopping and residential districts arouses the unrestrained admiration of the visitor. The country over, every pleasure car of this type means an additional revenue of from $1 to $2 per week for the central station supplying the charging energy.

Large as are the profits to be derived from pleasure-vehicle service, the opportunities offered by the electric truck far surpass them. For every class of mercantile and municipal transportation on the public thoroughfares, the adaptability, reliability and economy of the electric truck are meeting the most severe demands. Approximately 7000 such trucks are now in daily use in this country, representing a central-station income of not far from $30,000 per week. These represent probably one-third of the motor trucks now in service in the United States, and if the previous rate of expansion is carried along, in two years more the total annual revenue derived from the charging of commercial trucks alone by central stations will reach about a third of a million dollars. Every truck of this type which goes into service becomes a consumer of electrical energy to the extent of from 4000 to 12,000 kw-hours per year; but, more than this, every such vehicle tends to stimulate the purchase of others through the economies which it effects per unit of merchandise handled, and thus the practical results of operation under the severe conditions of modern trucking lead to a still greater use of electric transportation. In scores of cities the superior acceleration of the electric motor, the reliability of the simple mechanism required, and the corresponding low cost of operation and maintenance, are driving the horse out of the congested street and forcing the complicated and costly gasoline truck into long-distance service. The improvement of shipping conditions on wharves and docks, in narrow and crooked streets and alleys is so marked that the electric truck is becoming a privileged character in the eyes of the railroad and steamship companies, the police authorities and the insurance interests. The opportunities of such machines in fire department service, as emphasized particularly in the pioneer installations and repeat orders of the Springfield (Mass.) organization, literally open a new era to the truck manufacturer and central station. Nowhere else do reliability, speed capabilities under a moderate mileage per charge and flexibility of control count so much. And, although cost is a secondary matter in fire-fighting, it is noteworthy that even here the electric truck is winning victories as well as releasing an additional man per vehicle for active service at every fire. The magnificent possibilities of the electric truck are illustrated by recent estimates that the tonnage of street haulage is sixteen times that of train haulage, and that twelve times the present central-station load in Greater New York would be demanded if all street haulage in that territory were confined to electric trucks.

Points like these furnish the material for a publicity campaign of heroic proportions, and it is significant that such an effort to acquaint the public with the existing service and immediate possibilities of the electric vehicle has been under way for some months in the East, with full recognition of the importance of carrying the firing line forward in 1912. The co-operative work of the Electric Vehicle Association of America, the Electric Vehicle Club of Boston, the Boston Edison company and other parallel central-station and manufacturing interests is bringing about a new and enlarged interest in electric-vehicle transportation all over the country. More than a million dollars' worth of trucks are now going through the factories; the discriminating public is growing more and more to appreciate the distinction and convenience of the pleasure car, and if the triple alliance of the central station, the vehicle and accessory manufacturer and the economy-seeking business public continues to find common interest in this typical twentieth-century electrical product, the benefits assured to all within the next few years will surpass even the expectations of the present leaders of the industry.

ELECTRIC HEATING.

FOR a long period, dating back even to the World's Columbian Exposition in 1893, electric heating enjoyed much exploitation but still comparatively little real development. During the past several years, however, there has been a marked advance in the quality and construction of the ordinary electric-heating appliances offered. Practical experience, too, with long-hour or unity-load-factor water heaters and fireless-cooker stoves has emphasized possibilities of domestic service in a new direction and on a new scale. Factory applications of electric heat are now also attracting central-station sales efforts, so that in general, looking ahead, one sees revealed in electric heating a future field of the highest promise. For more than any other single factor in this belated progress we have to thank those manufacturers who have insisted on the best and sturdiest construction of appliances. Devices generally are, as a result, now durable and satisfactory. Wire manufacturers have improved the homogeneity of their nickel and chromium alloys so that these resistor wires can be reliably drawn down to the smallest sizes, giving resistance units of a compactness heretofore impossible. Equally important with the resistor units are the insulating materials. Electrical insulators which will withstand high temperatures while separating electrical from non-electrical parts are already pretty well developed and satisfactory, although the theoretically ideal material which shall be at once an electrical insulator and a good thermal conductor for conveying the heat away from the wire has not yet been discovered. Badly needed, however, are better thermal insulators, materials which conduct heat poorly and can be used in heating devices to confine or direct the heat as desired. Silica, flint and alumina are among the best thermal insulators now used, and there seems to be nothing better in sight. As an example of the sturdy construction of recent apparatus above mentioned there may be cited one comparatively new immersion heater, the flat resistor element of which, insulated by sheets of mica, is clamped between two flat sheets of steel welded together along their

edges. Overheating this element in air, hammering nails with it, or even participation in a dynamite explosion would affect it little more than a steel stove lid of the same size. With such rigid construction available in more devices electric heating will have a new meaning. On the other hand, devices of the type of irons, immersion heaters, warming pads and special heaters need some practical, durable means for limiting the temperature below a fixed maximum, either by thermostatic cut-out or the temperature-coefficient resistance rise of the element itself.

The electric iron, of course, continues to hold its place at the head of the list of popular heating appliances. In 1910 it is estimated that 300,000 irons were sold. Almost as many were disposed of in 1909 and in 1908. Irons as ordinarily used are good for a lifetime, so we may properly assume that most of those sold each year were bought by users new to the blessings of electricity in the household. That the saturation limit is not approached is shown by the growing number sold year by year, in spite of the increasing number already in service. In the year just closed an unexpected demand appeared for luminous-type twin-glower radiators, an unusual number of these cheery little comforters being sold. Popular-price cooking appliances of all kinds are in demand, although too many times this requirement of low price has been met by an inferior product with consequent failure and dissatisfaction. Electric cooking and water heating with continuously connected heating elements, taking low demands of power twenty-four hours per day, seem to offer the central station its long-sought opportunity for raising the residential load-factor. The principle of these devices is the continuous consumption of a low demand (150 to 500 watts, such as will not require special plant or distributing investment), storing up this energy as heat in heavy iron castings, for delivery later at a much higher rate when desired. In the water-heating system the heat is similarly imparted to the water through heavy iron castings. Curiously, however, no metal or other substance approaches water in its heat-storage capacity, although aluminum is one of the best in terms of heat units per pound of mass. In Cleveland a number of long-hour electric ranges have been installed, each having a 150-watt continuously connected unit and about 2000 watts in short-hour demand. Others of the new Stanley type about to be placed in service there have a load-factor entirely unity, their heating elements comprising one 300-watt and one 200-watt continuous heater. Baking and roasting are done in the ovens, while the red-hot mass of the larger heater casting can be raised to the upper shelf for frying, delivering its stored heat at rates as high as 4 kw if required. Provision is also made for heating water in the recesses of the oven. With such equipment it seems probable that the demand of the average completely electrified household can be kept down to 1500 watts for cooking, water heating and lighting, entailing a great saving in central-station investment over high-demand apparatus. While cooking with the storage range is admittedly less efficient in point of kw-hours consumed than with high-demand ranges, it seems likely that with the low rates the electric companies can afford to offer for such twenty-four-hour load the actual cost will be much less. Improvements are also to be recorded in high-demand fireless-cooker ranges, new products that have appeared within the year being equipped with such conveniences as thermostatic cut-offs, clock switches for starting, interchangeable heating elements, etc. But in adapting any of these devices to domestic use the problem seems to rest rather in the conversion of the housewife to improved methods of procedure than in any limitations of the present apparatus itself.

Industrial uses of electric heating are becoming of increasing significance. The close temperature control and absence of flame and smoke make this form of heat desirable for many uses over any other and cheaper means. Electric heat has long been applied to candy making, matrix drying, electrotyping, laundry machinery, hat making, glue warming, etc. Small celluloid factories that heretofore required high-pressure steam heat now use electric heaters safely and satisfactorily. Baking is already being carried out on a practical scale by electricity at a low cost per loaf. The baker's frying pot, too, offers a good chance for electrification on grounds of safety alone, obviating many dangerous fires in bakeshops. The same may be said, of course, of all the glue and varnish pots which are necessarily used among inflammable materials. The operation of enamel-baking furnaces on an off-peak basis is another desirable load recently discovered by an Eastern central station. All during the day the enameled parts are piled into the ovens, which are closed at the ends of the working hours. At 11 p. m., after the system peak has been passed, a time-switch turns on the heaters, cutting them off again at 5 a. m., just before the morning demand. When workmen appear at the usual hour the parts are taken out of the ovens properly enameled. A similar plan of automatic control might be adopted for many other industrial heating operations, filling in at a profit the load curve for those periods which are indeed the "wee sma' hours" for the average central station.

ILLUMINATING ENGINEERING.

THE work of development in illuminating engineering during 1911 was confined more largely to the application of previously determined theories and dissemination among the multitude of the information formerly held by the select few than to the discovery of new principles or acquirement of much additional information as the result of research. Six years have now passed since the society dealing exclusively with this subject was organized by a few enthusiasts, some of whom were bold enough to predict a final total membership of 1000. If numbers can be taken as a criterion of success, then the work of the society has already proved 50 per cent more successful than anyone expected when it was organized. No one can doubt that its work has been of a helpful and lasting kind. Many of the relations now treated as fully established were the subjects of considerable discussion at its meetings, which served to bring the facts to light and place them on record for those most vitally interested.

The past year has witnessed an increasing interest on

the part of the general public in the use and abuse of artificial light, and an increasing appreciation on the part of illuminating engineers in subjects associated with, but yet different from, the simple physical relations involved in illumination calculation. The effect of light upon the eye, glare, acuity, color sensation, etc., are now considered to be quite as important as "effective lumens," "mean spherical candle-power" and similar details, which received the undivided attention of these men only a few years ago. That all knowledge obtainable on the engineering of illumination has already been acquired is very far from the truth, but the fact remains that illuminating engineers are taking a step in the right direction in broadening their field of effort to cover the various subjects closely allied with illumination topics. No more important work can be undertaken at the present time than the general dissemination of knowledge of simple fundamental relations in artificial lighting to the general public, who, in the last analysis, are the ones to be benefited by the study devoted by the few to illuminating engineering subjects.

ELECTROCHEMISTRY.

AS has been the rule in recent years, nothing of a character that could be used here with pyrotechnical effect has happened in 1911 in the older electrochemical industries of aluminum, calcium carbide, carborundum, artificial graphite, caustic soda and chlorine, electrolytic copper refining, etc. These industries are firmly established, financially flourishing and quietly and energetically extending their commercial spheres of influence. On the other hand, the fixation of atmospheric nitrogen and the applications of electrochemical methods in various fields of metallurgical practice are still to a greater or less extent in the more interesting stage of evolution. The new plant in course of erection in the South for the manufacture of nitrates from the air is not yet in commercial operation. The older works in Norway have stood well the crucial test, and have established a well-paying industry, though under most advantageous conditions of cheap energy. It is reported that contracts have been made in Scandinavia for hydroelectric power at a rate even below $4 per annual horse-power. From a technical standpoint the result of the operation side by side and under the same management of the Schoenherr furnaces of the Badische company, with their long arcs around which the air travels in a spiral path, and of the older Birkeland-Eyde furnaces, with their magnetically produced flame disks through which the air passes, is of considerable interest. Practice has shown that for large units—and the tendency is naturally toward larger and larger units—the compact Birkeland-Eyde furnace is the more economical.

In the applications of electrochemistry to metallurgy the electric furnace for steel refining continues to rank first in interest. The chief progress made in this field in the past year relates to a mere detail, which, however, is of fundamental importance. This is the baking of large amorphous carbon electrodes such as are needed to assure the commercial success of the large electric furnace which is required in the Bessemer converter-electric-furnace combination for large-ton products, like rail steel, etc. An enormous amount of experimental work has been done on the baking of large electrodes to render them mechanically strong and not liable to break under the severe conditions of practical use with rapid changes of temperature, etc. It is on the success of this experimental work with electrodes that success of the big electric steel furnace for quantity products now hinges, if other solutions are not found, as, for example, in the pinch-effect furnace or in designs of the Roechling-Rodenhauser type. In the meantime the electric furnace has assumed a firm position in competition with the crucible process with respect to high-quality steels, and the electric furnace has also now successfully entered foundry practice in this country for the manufacture of special castings for auto mobiles, etc. With respect to the very different problem of iron ore reduction in the electric furnace, which is of special interest only for certain localities, like Sweden and Norway, Canada and California, the very careful and extended large-scale tests carried out at Trollhättan under the auspices of the Jernkontoret, the association of Swedish ironmasters, have brought out results of great technical value and have suggested important improvements in furnace design. This is indicated by the fact that quite recently (after reconstruction of the furnace) the specific output has been raised from 3.66 tons per kw-year to 5.05 tons per kw-year. In the meantime the Noble electric pig-iron and steel plant in California has been reconstructed and enlarged, but no definite results have thus far been reported.

In the metallurgy of gold electrochemical methods have come into prominence chiefly in two respects. Electrolytic amalgamation is being tried in the West, the mercury in the old amalgamation process being made the cathode of an electrolytic cell. The object is to keep the mercury surface always in perfect condition, ready to alloy with gold, the claim being made that the recovery of gold values is thereby considerably increased. But the process is still in the experimental stage. On the other hand, the Clancy process has just passed from the experimental stage into commercial practice by its operation on a large scale at the Ajax mine in Victor, Col. This is essentially a cyanide process, and its chief feature is the substitution of the much cheaper calcium cyanamide for part of the cyanide, in combination with electrolysis. However, the problem of treating complex zinc-lead sulphides—one of the big present-day metallurgical problems for which a definite solution will doubtless be found in the near future—shows best the great influence which electrochemistry now exerts on metallurgical research. The proposed solutions also indicate the remarkable variety of electrochemical methods. There are processes of roasting the ore and treating the oxide ore in the electric furnace, the chief advantage in this case being the substitution of a large working unit for the small zinc retort. Then there is the direct treatment of the sulphides in the electric furnace with iron as reducing agent. Then there are dry chlorination processes with final electrolysis of fused salt solutions, following along the lines of the former work of Ashcroft and Swinburne. Finally there is the proposal

of roasting and leaching for production of a sulphate solution, with subsequent electrolysis and recovery of sulphuric acid. Most of these proposals are on the verge of being tested on a larger scale. The statement of the results must be reserved for a future review—let us hope for next year.

THE STORAGE BATTERY.

IN storage-battery practice the tendencies of the preceding year have now become definite conditions, and to-day the demand for storage batteries for electric vehicles and train lighting is the predominant source of activity in the battery factories. The electrically propelled truck has proved more economical than the gasoline-engine vehicle for delivery service, and for urban service the electric pleasure vehicle is more convenient, safe and economical than the gasoline machine. Numbers of trials indicate that for the same conditions of loads, routes, distances and number of stops electric delivery wagons can be maintained and operated at about 60 per cent of the cost of gasoline wagons. As a result, the electric-vehicle industry has grown with enormous rapidity, expanding proportionally the demand for vehicle batteries. The promise of a satisfactory storage-battery-propelled street car has been fulfilled. The large number of cars of this type now in service on the lines of the Third Avenue Railway and scattered throughout the country have proved so successful that there is every promise that this method of railway-car propulsion in cities where the grades are small and headway comparatively great will become an important factor in street-railway development, and, therefore, will offer an extensive field for the storage battery.

The changing conditions of railway passenger service and the demands of the traveling public, together with growing requirements for public safety, have all contributed to the remarkable increase in electric train lighting which has recently developed, and increase in the production of storage batteries has necessarily been coincident. During the past year "stand-by" batteries have been installed in some of the lighting plants in large cities, notably an enormous equipment in Baltimore, and occasional factory and apartment-house equipments have been placed. The business in power batteries has, however, not been active, this condition arising from the fact that power batteries are used in industrial works, in electric-railway plants, or for line regulation on long feeders; and, since scarcely any new industrial plants have been built or new electric railways equipped during the past year, the opportunities for such batteries have been restricted. Happily, the battery manufacturers have been so busy making train-lighting and vehicle cells that they have not had time to mourn over the power-plant trade, and presumably their dividends will be as great as ever before. At any rate, it is a well-known fact that during the past year certain factories have been obliged to double the space and equipment required to turn out the vehicle and lighting cells demanded of them.

Pasted plates exclusively are now used for lead vehicle batteries, and have practically supplanted the Planté plate for train-lighting service and power-plant "stand-by" batteries. With the expiration of numerous patents the manufacturers have come to the same general form of pasted plate, namely, the staggered-grid type. The composition of the parts and the methods of formation may differ, but the net results all point to the fact that the lead-pasted plate has become simply an article of general manufacture without patented or "secret" processes, or any of the mystery that used to play so important a rôle in the trade. There has been a slight improvement in the output of pasted plate cells per unit weight. This is principally due to the use of thinner plates—a development which could have seen the light of day many years ago. The life, however, has been considerably increased, and this is one of the factors which have contributed to the low cost of electric-vehicle operation. For the past fifteen years some form of pasted plate surrounded by an envelope perforated with numerous small holes has made its annual appearance with resounding claims for durability and long life because the active material is mechanically forced to stay in place. The past year has been no exception in this regard, but it is yet to be established if the laws of chemistry and physics can be overcome by an overcoat. The Edison alkaline cell has come into extensive use for vehicle and traction purposes, and the prospects seem favorable for a still greater increase in the demand for these cells for transportable battery work. It is by no means to be expected, however, that they will supplant the lead-acid cells, as there are some conditions best suited to one and other conditions best suited to the other type. So far as such business matters are revealed, the indications are that the various manufacturing companies have had a very satisfactory year and look forward to 1912 as offering prospects for a still better one.

INDUSTRIAL ELECTRIC POWER.

UNDER the salutary influence of highly specialized and organized sales forces, central stations have not only made unusually great inroads into the isolated-plant field during the past year, but have materially checked the advance of further installations. Indeed, so marked has been the effect that protective organizations have been formed to combat further central-station encroachment, and concerted action is now being taken by a number of associations representing the isolated-plant industry against one of the largest electric-light companies in the country, on the ground that its rates for industrial service are too low. This swing of the pendulum in the other direction is no doubt largely due to the closer study which during the past several years has been made of the elements in the actual cost of electric service, the greater skill on the part of solicitors in presenting the advantages of central-station service, and, in the case of industrial plants, the expert aid now offered by the larger lighting companies in the laying out of power equipments and in assisting to keep up efficient operating conditions.

There are close to half a hundred good reasons for the use of electric power known to every good solicitor, but it

is only necessary for him to have at his command half a dozen. The superficial solicitor's chief stock in trade is a low rate, and it is wonderful to note how he can wield it to advantage; whereas the solicitor who knows his business has grounds more relative than this and has done most to quicken the interest of the manufacturer in the cost of power production. Manufacturers, as a rule, are in a receptive mood and welcome suggestions which when acted upon result in cutting down the cost of power. The central-station solicitor has the facts at his command, whereas the manufacturer is more or less in the dark and little realizes that unnecessary belt and shaft friction oftentimes doubles his energy costs. It is a question which is the more eager, the manufacturer to cheapen his cost of production or the central station to secure the day load thus afforded. Both represent excellent desires, and the ability to obtain reliable and cheap central-station service has induced many a manufacturer to locate in a community having such an asset. Enterprising boards of trade also realize the advertising value of efficient electric service to a city and are not remiss in proclaiming it.

Central-station men know the ubiquity of the electric motor. The National Electric Light Association has compiled reams of information on its application, as well as valuable data on the power requirements of machines used in almost every industry. Much work is still to be done, however, in disseminating this information among possible users of electric motors; for in cities of the first class the income from lighting represents approximately 70 per cent of the total. It is easy to demonstrate the superiority of the electric motor over any other form of prime mover, for a trial convinces; but it is necessary at the same time to bring out prominently and convincingly those characteristics of central-station service which render its use essential to any scheme of cheaper power production. The generation and marketing of electrical energy is the legitimate business of the central station. Its reputation for reliable service is safeguarded at all costs, and in order to keep abreast of the art it must not only install the most modern and efficient apparatus, but must place that equipment in the hands of a staff of highly skilled attendants. The ever-increasing number of plants converted to electric drive is proof of the sufficiency of the electric motor in the industrial power field.

THE TELEPHONE.

THE year 1911 has witnessed a steady and healthy growth in the telephone field along logical and well-established lines, but it has not developed any radical change or tendency. To be sure, it was ushered in with the announcement of the invention of a system of multiplex telephony using high frequencies, but this system has thus far had no apparent effect upon the art. The laws of transmission losses, stray induction, etc., appear to apply with added force to the multiplexing means employed—the superimposition of high-frequency currents—and it has for its problem the overcoming of attenuation upon a commercial basis. It may be well to note that this commercial factor is no small one in determining the practical limits of long-distance transmission. If the revenue side of the question could be disregarded, there seems little now to prevent the extension of the long-distance range from ocean to ocean. This revenue factor is, however, an all-important one. The circuit cost must not be such as to require a prohibitive rate. The evident task is, therefore, one of increased transmission efficiency and decreased cost of construction and maintenance. To-day 2100 miles is the limit of commercial service—from New York to Denver—and while it seems a long cry to the 3500 miles from ocean to ocean, this service is apparently almost within reach.

In the railway dispatching field the telephone has continued to supplant the telegraph with amazing rapidity. It seems to be the opinion of the majority of those competent to judge and who have had a comprehensive experience with both systems that the telephone far surpasses the telegraph for this service. Not only has the telephone the marked advantage that little manual skill is required to manipulate it, but it may be forced to work over lines absolutely impenetrable to telegraph signals. Thus, in times of storm, the telephone has been found the more reliable, especially as there is always indication of whether or not the message has got through. Again, the feeling of intimate contact which is engendered by the transmission of the voice has brought about a spirit of greater mutual cooperation along the dispatch line. Errors have been reduced by the telephone, as the tendency to short cuts and to too rapid sending is reduced to a minimum. This is especially so when the message is recorded at both ends simultaneously with its transmission. Moreover, the speed of the dispatch system is bettered, and at this time the ultimate universal adoption of the telephone for dispatching seems almost a foregone conclusion.

The so-called unification of the telephone and telegraph services has continued to progress. This movement is evidenced in the Central States, where five of the Bell companies have during the year associated themselves in a single unit. This group covers the greater part of the States of Michigan, Ohio, Indiana, Illinois and Wisconsin, including the great cities of Chicago, Cleveland, Detroit and Milwaukee. This makes one more experiment in large-scale organization on the functional principle, which seems to have several things to commend it, but nevertheless runs counter to much experience. Somewhere between the grand executive head and the working employee the organization must break into its functional parts, but where and how that break should occur is by no means settled. The trunk-line railroads, which are both older and richer in experience than the telephone companies, have fought out this question and in the main hold to the opposite, or divisional, organization. It is significant that both the Bell companies and the Western Union Company were formerly organized on the divisional plan, but each with perhaps peculiar weaknesses.

It is always difficult to compare a previous organization with its successor, because so many changes in personnel occur, which in themselves are sometimes of greater importance than the mere form of the organization.

The efforts to bring about co-operation between the telegraph and telephone services continue. There are now many joint telephone and telegraph stations; in some instances the telephone companies are acting as agents for the telegraph company in the collection of telegraph accounts, and there are reports of an increasing joint use of pole-line facilities. The organization of the Telephone Pioneers of America should not go unnoticed.

WIRELESS TELEGRAPHY AND TELEPHONY.

THE tendency in the construction of wireless apparatus during 1911 has been toward refinement of details with the purpose of increasing operating efficiency, and, in wireless signaling broadly, toward the settlement of numerous technical, legal and commercial difficulties which were previously sources of much uncertainty. The general telegraph service has been slightly improved by the closing of numerous wireless stations which were unnecessary in the handling of wireless traffic, but had proved to be useful advertisements. Transatlantic telegraphy between Nova Scotia and Ireland is continued, but the speed and reliability of transmission do not appear to be better than formerly. A new high-power station has been erected at Coltano, Italy, which is reported as having available a 1000-kw sender and from which messages are said to have been sent direct to Glace Bay, Nova Scotia, a distance of some 4000 miles. The navy's new station, near Washington, which is to have one 600-ft. and two 450-ft. towers in combination with a 100-kw transmitter, is well under way. This outfit is expected to have a daylight range of 3000 nautical miles, by reason of what is claimed to be a better electrical design than is usual in stations of more than a few kilowatts power. Messages from the installation at Clifden, Ireland, which has a 400-kw equipment, are said to have been heard in South America, 7000 miles away.

While the number of paid messages handled by coastwise ships is not large at the present time, possibly on account of occasional irregularities in the service, the wisdom of the compulsory wireless installation law which became effective last July has been well proved by the use of the wireless telegraph in the rescue of a number of perilously situated ships in the past twelve months. A point which has come to light is that many ship space-telegraph stations depend for their power upon the ships' dynamos; hence, in case of accident, as soon as the engine room is flooded the wireless transmitter goes out of commission. It is anticipated that this dangerous condition will be remedied by the federal requirement of auxiliary transmitters or power equipment, so that the call for aid may be sent out even though the ship's power supply be cut off. The cry against amateur operators as menaces to the successful exchange of messages has been raised several times during the year. Professional wireless telegraphers seem convinced that many of their troubles are caused by the stations operated for personal amusement. Occasionally the experimental station has better designed apparatus than the commercial plant of older date, and the amateur operator of a fairly powerful transmitter is often not of sufficient technical ability to adjust his apparatus properly. In this case his noise-like, highly damped radiation is a nuisance to all stations about him. However, whether the troubles arise through malicious intent or through ignorance, the imposing upon all stations of government inspection and license will be a necessity if the difficulties persist. Throughout 1911 the use of high spark frequencies (of the order of 1000 per second) has been on the increase. The clear whistling tone so produced has proved itself far superior to the old low-frequency hums, hisses and rattles, and the "high note" is now considered the basis of the only really practicable method for use in the tropics, where the static interference or "atmospheric" is bad. The apparatus for high-frequency spark transmitters is being widely copied and is thought to be an important element of modern wireless equipment.

The Patent Office records seem to show fewer novel appliances than in former years. In new apparatus the trend has been toward simplicity with increase of both electrical and operating efficiencies. Some designs, notably a few of those imported, have rather overshot the mark, in that characteristics necessary for service under severe interference conditions are sacrificed in the attempt to secure some other desirable features. Valuable work on the standardizing of engineering practice and methods has continued, and many useful investigations into the matters underlying details of design have been completed. Among old problems which have been taken up and reduced to a working basis during the year are the effects of varying absorption in daylight signaling, the theoretical comparison of various types of antennæ in actual use (as contrasted with the simple oscillator), and the predetermination of station effectiveness. Instead of the haphazard inspirational treatment which has so long characterized the handling of wireless, real engineering methods are now successfully applied.

In the first part of the year the activities of the federal government in the prosecution of several wireless companies for fraud culminated in pleas of guilty, convictions and imprisonment of the officers of one of the most active corporations. It is believed that the government will continue to press its cases against other wireless companies which are alleged to be guilty of fraudulent manipulation of valueless stock sustained by illegitimate wireless advertising, promises and fictitious claims of communication. An important court event of the year was the decisions of United States courts upholding what is claimed to be a fundamental American patent on "double tuning" at sender and receiver, and covering the use of current-operated detectors, which are defined as having "all their contacts good contacts," as opposed to the old loose-contact voltage-operated coherers. The cases have gone to appeal and will reach their final hearings early in 1912. It is, of course, impossible to foresee the decision on appeal, but, whether the patent in question is or is not sustained, the final result will be a great clearing of the sadly vexed wireless patent situation. Several other letters patent, owned by various wireless interests, are now in suit, and decisions in these cases will further ameliorate the situation. There have been few announcements of progress in wireless telephony during the past twelvemonth, and, what is perhaps more

strange, almost no luridly optimistic prophecies. It would appear that the development of the telephonic branch of wireless signaling has been set aside until the transmission of dots and dashes reaches a more sound basis. This is to be regretted from some points of view, although it will probably result in good, in that a firmer foundation for the wireless handling of communication traffic will be reached. Some successful tests have been made with small wireless telephones having a speaking range of less than 50 miles, but the higher power work seems to have been definitely laid aside for the time being. It is to be hoped that the coming year will bring forward new and actual advances toward the securing, via wireless, of distortionless and non-depreciatory trunk lines.

TELEGRAPHY.

DURING the year just finished the telegraph industry has shown gratifying signs of a general awakening to its possibilities. Although it possesses the dignity of being the oldest of the electrical arts, its modern contemporaries have far outstripped it in progressive advancement. Communication, regarded as an industry, comprises three branches, which consist of the government postal service, the telegraph and the telephone. These three are competitive only in the extent to which they overlap in fulfilling the same classes of public needs, while in the main each has a field which is peculiarly its own. When the mails are too slow or too cumbersome we resort to the telegraph or the telephone. The latter performs its greatest work in local and short-distance service, reaching out to moderate or even long distances for those who can afford it. But the long-distance business belongs naturally to the telegraph, both because it is cheaper and because it encounters fewer physical difficulties in transmission. Quite obviously the telegraph also meets numerous wants in the field of short-distance communication, but these, while important, do not compare, for example, with the value of the ocean-cable service.

Two companies have practically controlled the land-line business in America for a long period. Until recently both were practically isolated from the telephone industry, and one might say that between telegraphy and telephony there existed a sort of rivalry which even extended sometimes to mutual scorn. That this was a wasteful policy is evident, but at last the potential possibilities of co-operation have been recognized, and we are commencing to enjoy the fruits. The first step in this direction was the acquirement of a large holding in the Western Union Telegraph Company by the Bell telephone interests. A partial reorganization followed in a short time, and the immediate public benefits were the inauguration of day and night letters and much closer relations with local Bell companies for the collection and delivery of telegrams over the telephone. One of the ancient stumbling blocks in the way of telegraph development has been the slow and unsatisfactory method of collecting and delivering telegrams by messenger boys. The substitution of the telephone is a great advance and should do a great deal toward popularizing the telegraph service. A further advantage lies in the arrangement whereby any telephone subscriber may deliver telegrams over the telephone to the telegraph office and receive the bill therefor with his regular monthly telephone statement. This saves both time and annoyance and shows how non-competitive forms of service can be made supplementary. Deferred cable rates, cable letters and week-end letters, at reduced tariffs, have been the latest form of new service. Reduced rates for transatlantic service are possible, for the reason that the cable facilities have never been loaded to capacity, even at the peak of demand, and naturally the unused capacity at times of least demand is very large. It is obviously possible to utilize this capacity with limited forms of service, just as it is feasible to give diminished rates for night long-distance or toll service or night telegraph service. Telegraph communication is the more flexible, however, owing to the larger time element in transmission, which makes it possible to offer more combinations or different forms of delayed service. The Mackay interests, in control of the Postal-Telegraph-Cable Company and the Commercial Cable Company, have closely followed the lead of their competitors in establishing new forms of service. In seeking telephone co-operation they have naturally turned to the Independent field and in a few instances have already established close mutual relations with Independent companies. The Mackay companies some time ago disposed of their holdings of Bell stock and have announced their policy as independent and competitive. The arrangements for co-operative service and joint use of facilities are necessarily made rather slowly, owing to the lack of a central organization in the Independent telephone field. Business or traffic arrangements are more readily consummated than the physical changes preparatory to bringing the plants together. Neither of the telegraph companies has yet achieved anything of a comprehensive nature along these lines, although it has been announced that such changes are in view.

The telegraph in the railroad service reaches the high mark, so far as the annual number of messages is concerned, being nearly double the entire commercial business. But the telephone is rapidly encroaching upon this record, as regards both train dispatching and railroad business. Approximately 25 per cent of the railroad mileage in the United States is now dispatched by telephone, and the proportion is constantly increasing. The telephone is found to be quicker, more flexible and fully as accurate. But the telegraph is still retained for long-distance service, and, of course, it will always produce economies through the simultaneous use of lines for both kinds of service. Technical progress in the art during the year past has been notably along the lines of improved equipment and better operating efficiency. There is considerable satisfaction in noting the tendency to bring a much larger measure of science and engineering skill to the industry than it has heretofore enjoyed. The ancient idea that one could not understand the business unless he had been an operator is happily passing, and the importance of technical training is beginning to be perceived. There is a vast field here for good engineering work, to which men of ability will be attracted as fast as it becomes profitable and the working conditions are made congenial.

RURAL ELECTRICAL DISTRIBUTION.

MORE attention was paid by the electrical men of the United States to rural electrical distribution and to the electrical needs of the farmer in 1911 than in any previous year in the history of electrical development in this country. The importance of the subject is beginning to be realized generally instead of in scattered localities, and electrical men exhibit some tendency to make an intelligent study of it. This recent access of interest is more conspicuous among operators of electric-service companies, as the manufacturers of gasoline engines, storage batteries, small dynamos and motors and the various classes of electrical apparatus adapted for use on the farm have realized the existing opportunity for several years. The variety of isolated-plant combinations for supplying electrical energy now offered for sale to agriculturists is surprisingly large, and the number of gasoline-engine, gas-producer, steam-engine, oil-engine or water-power private electric plants actually installed on the farms of the United States is much greater than is generally supposed. Let any electrical man who desires enlightenment on the activity of the isolated-plant manufacturers in this field visit the next state fair in his neighborhood and see the variety of farm power plants offered for the inspection of possible buyers. Many well-to-do and enterprising farmers are interested in the use of electricity for lighting and motor operation, but as probably less than 30 per cent of the farming population of this country have access to electric service at present it is not surprising that the proportion of private plants is large—large, that is, compared with the total number of users of electricity outside the cities and villages, although the total number of such users is still very small compared with the farms where electricity is unknown.

There is thus a great field for possible electric service which is almost untouched. Is it worth cultivating? Should the farmer use electric light, chop his feed and shell his corn by electric motors and provide his wife with an electric flatiron? If so, can the electric-service company sell him electricity at a price he can afford to pay and at the same time make a fair profit for itself? These are the questions to which increased attention has been paid by central-station managers during the last year. The most ambitious study of the question was made perhaps by a committee of the National Electric Light Association, which presented an elaborate report on "Electricity in Rural Districts" at the New York convention on May 31 last. There have been a number of papers on the subject also at state electrical conventions, notably at the Illinois meeting in Rockford last October, while non-electrical bodies, such as the American Society of Agricultural Engineers and others, have discussed the subject. The *Electrical World* has paid much attention to the generic subject of "Electricity on the Farm," and the titles of articles related to it and published during the year in this journal would make a rather formidable list. It should not be forgotten also that some of the electrical and agricultural manufacturing companies have lately issued valuable bulletins on the subject.

The National Electric Light Association's committee, through its chairman, Mr. J. G. Learned, of Chicago, expressed its belief that many profitable rural consumers can be secured, taking enough energy to pay the electric-service company for the effort to reach them. It pointed out that the farmer's power business is an off-peak load and that his lighting peak is often off-peak also. Although it is often a difficult matter to secure the farmer's business, once obtained, with the flexibility, economy and convenience of the service, it usually results in a contented customer with a tendency to increase his installation. The committee gave a number of pictures of farm installations and a table to show the power required by some kinds of power machinery. It discussed irrigation, drainage and rural industries to some extent, and said that education is the primary need. It made several recommendations, among them that the United States Department of Agriculture be urged to prepare and distribute a bulletin on electricity on the farm, and that the National Electric Light Association adopt resolutions defining its own position on the subject. So far as known, no action was taken on these recommendations, so that, while it is true, as previously stated, that more interest is taken in the subject than ever before, it will be understood that much remains to be done to arouse interest in the great mass of operating men who are only dimly interested in a future possibility. Mention should not be omitted of the broad policy of the Ontario Hydro-Electric Commission, which will supply farmers from its great transmission network, thus introducing on this continent on a large scale the practice which has been so successful in North Italy.

One advance that has been made is in designing transformers suitable for installation on farmers' premises, stepping down the potential of high-voltage transmission lines directly to 110 or 220 volts for service. The report referred to above said that present general practice is to use such transformers with as high as 8000 or 10,000 volts on the primaries. It is now declared that transformers are available for this purpose, operating on 25-cycle or 60-cycle transmission circuits of 6600, 13,200, 16,500, 22,000 and 33,000 volts. These transformers must have a high factor of insulation, and questions of lightning protection and grounded secondaries also arise; but the manufacturers assert that these difficulties have been met successfully. Transformers of this sort may do much to solve the problem of selling electricity to the farmer from a distance. To reduce the expense, iron wire is sometimes used for the secondaries and even for the transmission circuits. There are not a great many installations of this character, however, and there is a question whether it is wise to introduce this variation from a standard construction. Ordinarily an effort is made to serve a group of farm customers from one transformer reducing transmission potential to, say, 2300 volts, with service transformers on the customers' premises. An effort is often made to have the farmers pay for all poles, wire, transformers, lightning arresters, etc., connected to the transmission line. Where land is valuable and labor high farmers are sometimes willing or even eager to do this. Instances are known where the right-of-way for a transmission line could be secured only on promise of giving service to farmers along the route

The subject of rural electrical distribution is beset with difficulties, but they are not insurmountable difficulties.

The big outstanding fact is that over one-half of the population of this country lives outside the territory now served by the electric central-station companies. There is a demand for electric light, motors and heating appliances on the part of a certain small proportion of this unserved multitude. This demand is bound to grow with the diffusion of knowledge and the increase of wealth. In many instances, as where small water-powers are available, or on the country estates of wealthy men, or in other cases, private plants meet the situation satisfactorily. But the average farmer, when convinced that he wants electricity, would prefer to buy it, probably, rather than to make it. The problem confronting the electric-service man is to figure out a way not only how to meet this demand, but to encourage it, to educate it, as a part of his future heritage.

PHOTOMETRY.

NOTEWORTHY of late in photometry is its development from a simple geometric science to a complex science that involves not alone physics and mathematics, but physiology and psychology as well. Until a few years ago photometry was almost entirely concerned with the measurement of lights of the same color, and the common photometers and the common standards of intensity are all developments of this epoch. Almost the only characteristic required of a photometric standard was reproducibility, and so far as the photometric operations were concerned a bolometer or other instrument sensitive to radiant energy might have replaced the eye. The simultaneous development of light sources of varied color, and of the science of illuminating engineering with its new ideals of light distribution, has brought changes. Study of the eye and of the consciousness behind the eye has become necessary, with results most stimulating to photometry. To this study may be ascribed almost directly the recent material progress toward the solution of the old questions of luminous efficiency and the scientific primary standard of light.

The problem of heterochromatic photometry is still of great moment. The difficulty in comparing the intensity of lights of different colors is largely that the eye cannot readily separate the brightness quality from the color quality. By dint of making numerous estimates, the brightness value may be reached—a time-consuming operation. A major problem of heterochromatic photometry is to find a quicker method, and of all means at hand the flicker photometer appears the most promising, for it undoubtedly makes possible a definite quick setting between lights of different color. It has remained to be determined whether the value it gives is the value reached by direct comparison. Great progress has been made in the study of this photometer in its relation to others. It appears probable that at moderately high illuminations the result it gives is the true brightness. But it has developed that in behavior under variations of illumination the flicker method indicates changes in the relative brightness of different colors exactly opposite to the changes (Purkinje effect) shown by direct estimation of brightness. The problem of colored-light photometry will not be entirely solved until the relationship between the criteria of all photometric methods is known under all working conditions. Substantial progress in this direction has been made in the past year by studies of the phenomena of persistence of vision which underlie the action of the flicker photometer. It may be predicted that the requirements of measurement will demand the use of that method which gives the best attainable balance between sensibility on the one hand and approximation to the most useful value as light on the other. This method, used under standard conditions of illumination and character of photometric field—chosen as being the most useful conditions—will establish the standard values of different colors. Their values under other conditions will be known from the information now being acquired through research. Differences in color vision in different observers will always complicate photometry of this sort, and the aim should be to confine all measurements of colored lights to the standardizing laboratory and to observers of tested color vision. In practical work the use of colored glasses or calibrated standards of different color will reduce all photometry to the simple photometry of lights of similar color.

Attention has been devoted of late to the question of efficiency in light production, or the ratio of the useful work performed to the radiant energy consumed. Considering luminous intensity as the useful work done by radiation, the different spectral colors differ greatly in efficiency. Consequently any mode of estimating the luminous efficiency of radiation which neglects the relative light values of different radiations cannot be satisfactory. Formerly this factor was given scant attention, but it is now becoming generally understood that the logical method is to estimate radiant efficiency in terms of the most efficient radiation possible. The result of thus calculating efficiencies is that the ratio of the efficiencies of two illuminants is also that of their candles per watt, which is as it should be. The study of luminous efficiency leads naturally to a logical primary standard of light. Consideration of the light value or efficiency of different radiations has brought the suggestion from three different sources that the primary standard of light should be derived from the measurement of radiant energy properly weighted to correspond to its value as light. Whether this be done by the use of absorbing screens, by diaphragming a spectroscopic device, or by the measurement of a selected monochromatic radiation both as light and energy, the result is to define the light unit by the least quantity of energy necessary to produce the standard intensity. The adoption of this standard would mean that the numbers indicating the efficiency and the candles per watt of an illuminant would be identical. The attainment of this logical scientific standard is largely dependent upon the establishment of methods or conventions in colored light photometry, for upon these depends the estimation of efficiency.

Photometry, however, cannot restrict itself solely to the question of brightness. There are other useful properties of light, such as the ability to reveal detail or motion. Some of these properties have been used as the bases of methods of photometry. None possess the requisite sensibility for exact photometry, but it becomes necessary to

know how their criteria compare with the brightness criterion. Considerable work has been done during the year on visual acuity with lights of different colors and different qualities. It has been found that, in consequence of the eye not being an achromatic instrument, monochromatic light sources possess decided superiority for revealing detail over other lights of the same brightness. Further researches have shown visual acuity to be greater by the light of the middle of the spectrum than by the light of either end. The exact evaluation of quality factors to be applied according to the intended use of a light constitutes an interesting future problem for photometry. Side by side with the development of these newer phases of photometry steady progress is being made in instruments and methods of standard type. The development of the present light standards, such as the pentane lamp, is being carried on in the direction of increasing reproducibility, and in increase of our knowledge of the effects of temperature and other variables. The demands of illuminating engineering are reflected in the development of instruments for measuring surface brightness and in methods of calculating the illumination from extended light sources. Nomenclature and standards of photometry have received attention from various bodies, too often working independently. The Illuminating Engineering Society has taken the lead in proposing for the near future an international conference of all bodies interested in photometry. The settlement of uniform names and symbols not liable to confusion with those of allied sciences should follow from the formation of such an international body. Later, methods and conventions to be adopted in heterochromatic photometry may well claim attention, and ultimately a primary standard of light, perhaps along the lines of the proposals here reviewed, may be established.

PRIME MOVERS.

IN the field of prime movers and motive-power equipment in general the year has been marked by a conservative yet a steady advance along definitely established lines, with here and there something new and thought-compelling, such as the astonishing results realized by Professor Bone's experiments in so-called "surface combustion." No change of significance has developed in the fuel situation. Some attention continues to be given to the utilization of peat and to the processes of briquetting for the utilization of coal wastes, but not in the serious manner which must mark the study of these problems in the near future. In general, oil fuel seems to be attracting an increasing amount of attention in the fields where coal has hitherto been the normal fuel; and its many peculiar advantages will undoubtedly lead to a continued extension of its use, limited only by the resultant over-all economy as dependent on its cost relative to coal. One drawback under which the use of oil has always labored is the cost of atomization expressed as a percentage of the steam generated. Experience shows that with atomization by steam direct from 3 to 4 per cent of the water evaporated in the boiler is required by the burner, thus constituting a direct tax of this amount on the actual boiler output. With atomization by compressed air the economic results are but little better. During the past few years, however, and in increasing degree during the past year, increased attention has been given to methods of mechanical atomization, with or without some degree of vaporization external to the furnace. The results by some of these methods have been very hopeful and there are to-day several plants in operation where the expense for atomization is represented by little, if any, in excess of 1 per cent of the boiler output. This is a point worthy of the most serious consideration, and engineers contemplating the use of oil would do well to study carefully the possibilities presented by these methods.

It is still true, as perhaps it always will be, that in the steam-driven power plant the part susceptible of the greatest improvement in economy is the boiler-room. Careful tests during the year, as well as previously, show that under the best conditions a boiler economy of 83 per cent may be realized. It is not probable that in power plants the country over values better than from 75 to 78 per cent are maintained. The demonstration of a top-notch value by some one plant is a fine achievement as pointing the way, but it is of vastly greater import to endeavor to raise the average up toward some such attainable maximum. Increasing attention seems to be given to flue gas analysis and to CO_2 recorders, and to the intelligent interpretation of their results, to methods for controlling and regulating air supply, to methods of securing as nearly as may be a definite program of operation for the boilers which shall insure periodic and systematic overhaul and cleaning at not too long intervals, to means for absorbing the heat in the escaping flue gases down to the minimum temperature, and in general to the many factors on which boiler economy depends. These all merit continued and earnest study and every power-plant engineer should set before himself as a goal the progressive elevation of his boiler economy step by step until it represents the maximum practically attainable under his conditions of operation. The two most interesting events of the year in connection with the boiler are the installation of the huge units in Detroit, recently described in these columns, and the work of Professor Bone, of Leeds University, England, in connection with the combustion of gases and vapors at lower temperatures than those prevailing in the usual form of so-called explosive combustion. Professor Bone takes advantage of the basic fact that various combustible gases may combine slowly into oxygen at a temperature slightly below that necessary for the more rapid combination known as normal combustion, and that this rate of combination can be greatly accelerated by the presence of porous substances such as porcelain or firebrick. The result attained by the development and application of these facts is in brief the combustion in a boiler tube filled with broken firebrick of a gaseous fuel mixed with air, burning without flame or noise, and resulting in the evaporation of about 21 lb. of water per square foot of heating surface and with a thermal efficiency of about 93 per cent. This is an evaporation from six to seven times the normal rate of output, and at an increase of some 20 per cent in efficiency over the values for normal boiler practice. It is too soon to appraise these results properly as to their possible effect on the

future of the steam boiler, but they appear to be of the deepest significance, and the engineering world will await with eagerness the results of further study regarding the practical application of these principles.

Turning to the field of prime movers, the steam turbine, which has now reached the 20,000-kw stage, has become more and more definitely confirmed in its general hold on the field of large central-station practice, while the reciprocating engine divides with the internal-combustion engine consideration for small units for electric power generation. The general causes for this growth in the use of the turbine have been made too frequently the subject of discussion in these columns and in the engineering press generally to call for further special consideration. Like all other problems of power-plant practice, the ultimate choice must be determined by reference to the over-all station economy—the ultimate cost of a unit of energy output including fixed and operating charges of every character. Judged by this standard, the steam turbine has demonstrated its superior fitness as the prime mover for large central-station generators, and the immediate future seems to hold no promising rival. Some further instances of the combination of reciprocating engines with exhaust turbines have occurred, for the most part in connection with previously installed engines, but in one, at least, as a primary installation. In one such installation in the Chicago & Northwestern terminal in Chicago, recently described in these columns, the reciprocating engines are intended to carry the load in general, operating non-condensing and exhausting into the heating mains for supplying steam heat to the building. On this program they will give 1 hp-hour for 18.6 lb. of steam. At times, when no heat is required, the exhaust from the reciprocating unit is sent to the turbine unit, which will give a kw-hour for 43.5 lb. of exhaust steam. This combination works out with a final consumption of 11.8 lb. of steam per hp-hour.

The competition between the turbine and reciprocating engine as prime movers has recently received certain new and significant elements resulting from the very marked advances in economy made by the latter in small units. The astonishing economy realized by the German so-called locomobile or semi-portable type has been widely noted in the engineering press, which type of American manufacture will soon be available. No less significant are the results reported in connection with the Stampf uniflow type of engine. These and other features of engineering practice in connection with the details of design and construction have shown that the economy of reciprocating engines, even in small sizes, may be reduced to hitherto undreamed of figures. In fact, the reciprocating engine in point of thermal efficiency alone presumably still holds the record, and in small sizes has realized results far beyond anything so far approached by the turbine in similar sizes. These facts will have to be taken into account and where high economy in small units is of importance the reciprocating type seems likely to hold some portion of the field. In connection with the same topic mention may be made of the rather disappointing results with steam turbines in certain of our naval vessels, and the return to the reciprocating type of prime mover in more recent designs. This is apparently due to the simple fact that under the particular conditions prevailing in the naval service better all-round efficiency has been realized with one type of prime mover than with the other. In particular, the reciprocating type has shown much less cost for upkeep, superior readiness for service and a superior thermal efficiency over wide ranges of speed and power output. Mention should, however, be made in the same connection of the installation of a steam turbo-electric drive on a naval collier now under construction at Mare Island. The installation comprises boilers, turbo-generators and slow-speed motors directly on the propeller shafts. It is expected by the contractor that this combination will deliver a hp-hour to the shafts for about 15 lb. of steam. This installation will be watched with keen interest and its success will perhaps open the way for the further use of such form of drive in the marine field.

In the field of the internal-combustion prime mover there have been few developments of marked import. Engines of the Diesel type are working their way into a well-established measure of favor. Granted a suitable grade of oil and good mechanical oversight there seems to be no reason why this type of engine may not be counted on to give reliable and satisfactory service. In moderate sizes, or up to about 300 hp, it now offers economy of the highest order and with proper oversight and grade of oil recent evidence and testimony all go to show that satisfactory and reliable service may be secured. It may here be stated that according to recent reports the manufacture of the Diesel engine on a large scale and in sizes up to 5000 hp will soon be undertaken in this country. Oil-gas-producer sets for moderate powers, or up to about 300 hp, are also attracting much attention, especially in California. Several types are offered, and several plants are in measurably successful and satisfactory operation. Marked improvements have also been made in the normal type of gas or gasoline engine, in small and moderate sizes, with direct reference to central-station requirements, and there are indications of a consistent and continuous growth in the use of this type of prime mover for demands of this character. Through either engines of the Diesel type using oil direct or engines of the normal type using gas from oil gas producers, we seem to be steadily approaching a satisfactory solution, at least in small and moderate sizes, of the important problem of the direct utilization of crude oil as a source of energy in our prime movers. In large sizes there seems to be a halt in the utilization of gas engines for electric generator drive, and unless special reasons connected with the cost of the fuel enter into the problem the large gas engine can hardly be considered as holding its own with the steam turbine. Reference has frequently been made in these columns to the demand for higher economies, and for consistent detailed study of operating conditions with a view to the elimination of wastes so far as may be possible. The same demand continues and with ever a more insistent note. Competition, the principles of scientific management as applied to power production, the demand of the age for conservation of resources—all these constitute factors in a more and more emphatic demand for improved over-all economy, and the power-plant engineer, as never before, must set himself to

the study of his problems with the purpose of raising the economy steadily one point after another as he gains more and better control over the various avenues of energy waste. Economy and reliability are the watchwords of the day, and the progress of power-plant engineering in the future, as in the immediate past, will be governed primarily with reference to these two fundamental demands.

THE WATER-POWER SITUATION.

JUST at present the attitude of the government regarding the development of water-powers controlled by it is the subject of some public anxiety. At the basis of all considerations of this topic must lie the indisputable fact that every cubic foot of water which runs down to the sea with its energy unutilized is an actual economic loss. Obviously, the development of water-powers is not, like the development of coal lands, a proposition which tends to the exhaustion of natural resources. It is on the contrary the one thing which can save the natural fuel resources of the world from exhaustion within a comparatively brief period. Whether there is a water-power trust or not is a matter of dispute. We have always taken the attitude that there is not, yet we are disposed to agree with Mr. Pinchot that there is likely to be, at the pace things are going, within a comparatively short time. In point of fact, the public is not keenly concerned in the separate or joint ownership of any group of hydraulic powers, except in so far as the conditions of ownership may tend to influence the prices charged. It is no legitimate function of government to say that while A, B, C, D and E may each own a group of water-powers and develop them, yet they shall not undertake to co-operate by forming a single organization, ever provided that in forming this organization they live up to the spirit and the letter of the law. It is, however, a proper function of government to say that water-powers controlled by it shall not be given over to private exploitation by any individual or corporation without the right of the government to regulate the conditions of employment of the power and the price which may be charged the public for it.

It is this right of control which is the sole necessary safeguard for the people, who, in the last resort, are the owners of Uncle Sam's domain. It is for the interest of the people that the hydraulic resources of the country should be developed and developed as rapidly as circumstances warrant; and so long as the government has full control so that no possible combination can corner the market in the sense of being able to raise prices it does not appear to be a matter of moment to any consumer whether the powers developed are owned by one or many men, by one or many corporations. For engineering reasons, the physical union of properties is often desirable and should be encouraged, so that common ownership may bring distinct benefits. Unless the government holds the fullest control in the matter of regulating the use of the powers and the price at which power shall be sold, a water-power trust might be a very serious public calamity; but with this control its existence or non-existence should be practically a matter of indifference, unless one is a member of the groups of financiers now quarreling for the privilege of investing money in this particular manner. In the governmental control should be the most rigorous possible supervision of capitalization, lest at a later date power companies should howl for the right to raise prices in order to pay interest on the watered stock which, by the usual flimsy pretext, is held to be in the hands of the widow or the orphan whose interest should be protected. If there is any place where the old maxim of *caveat emptor* should be rigorously applied, it is in the scrutiny of the investments presented by some of these quasi-public enterprises. Even when formal attempts are made to regulate capitalization experience has proved that, of all innocent and inexperienced bodies, state commissions are sometimes the easiest to flimflam. There have been some striking instances of pathetic appeals on the part of over-capitalized railway companies to raise fares in behalf of their starving stockholders, although we are glad to be able to state that no electric light or power company, however over-capitalized, has yet fallen quite so low as to squeal for help in its financial hydraulics.

The upshot of the whole matter is that the government at the present time is little disposed to let its powers go in the future, as they have in the past, with no benefits guaranteed to the public. It is perhaps over-cautious in its fears lest some wicked trust may gobble up the water-powers. Yet its cautiousness would be exercised better in insuring itself an unbreakable grip on the control of the powers than in hesitating about permitting them to be utilized. The government ought to make such regulations as will safeguard every dollar that every honest investor actually puts into the development of water-powers for the general benefit of the community, and it should show absolutely no mercy to the dishonest dollar which does not represent investment and appears upon the books merely for the purpose of claiming returns from the people whose powers it seeks to exploit. Let us have full liberty, then, for the utilization of the nation's hydraulic resources, coupled with such complete control of the investments and the returns upon them, that no dishonest man or corporation will care to meddle with the situation. Honest men and honest corporations, and there are many of both, should have the fullest possible opportunity to "make good."

PUBLIC-SERVICE COMMISSIONS.

DURING the year 1911 several state commissions assumed the usual broad powers granted under new commission laws. The plans made for commissions in several more states are advanced so far now that it appears probable that the necessary enabling legislation will be enacted in 1912 or 1913. The number of legislatures that hold sessions in the coming year, however, is less than in 1911, so that the amount of legislation may be reduced somewhat in extent of territory concerned, if not in severity. Some of the 1911 legislation relating to new commissions is strongly restrictive. Other legislation, less radical in tone, appears to develop from a feeling that because one state has

a commission others should follow and that, in a word, it is a fashion to be followed. With more commission legislation promised, it is an opportune time to consider the subject of weakness in the personnel of state commissions as revealed by recent tendencies in legislation and the commissioners who thereby hold public office.

It will be conceded that the policy of regulation in some form is surely here to stay. Laws empowering commissions to assume jurisdiction over the affairs of public utilities are, or probably will be, on the statute books of most states. Some of these laws, like those of Wisconsin and New York, have been passed against rather strenuous opposition and without compromise to meet the views of corporate interests. Others, a little more moderate in terms, have been passed as a result of a compromise between various and conflicting interests. They may be less effective than the New York law, owing, however, less to the language of the laws than to a compromise policy of enforcement and to the personnel of the commissioners and the political, untrained staffs with which they are surrounded. In New York State the intent of the executive who initiated the present regulative legislation was to call new men of character to the service of the State. With that in view, amply salaries were provided for the commissioners. The experiment of giving men supervision over the operations of business concerns with which they were generally unfamiliar involved a loss of time for their education to meet the responsibilities of the office, but it has resulted far more satisfactorily than might have been anticipated. Unfortunately, a change in Governorship in the State has led already to the displacement of two commissioners who developed high competence, one in each district, to make room for men of active political affiliations. If this policy is to be continued, it will lead to a change in the controlling personnel of the regulating commissions which will have a serious bearing on their effectiveness. In other states the political character of the commissions has been apparent from the beginning. This is due to the prevailing practice of enlarging the authority of railroad commissions so as to include public-utility corporations conducting other kinds of business. This practice is not always wise, and it does not appear to be in the interest of the public or the corporations to compel one commission in each state to scatter its efforts among so many classes of business.

A subdivision of duties should be advantageous in a number of states. Although one-commission control has been notably successful in Wisconsin, some of the state railroad commissions have been notoriously inefficient. It is true that these commissions have had little authority. They have been created because of a rather indefinite public desire for the appointment of some regulating body; but, either at the beginning or by the displacement of original members, such bodies have deteriorated into political berths for favored individuals. To place a commission composed of men of this type in charge of the supervision of public-utility operations under the authority of a strong law, in order that the public interests may be protected, will lead to a farcical enforcement of the statute and eventual results that should be feared. If there is a weak law, weak men may do as commissioners until the public again demands new conditions of regulation; if there is a strong law, none but wise men should be chosen to attempt to enforce it. Where there are states that have such existing railroad commissions, composed of men who are conceded to be wholly incapable of the development and balance necessary to fit them to assume wide powers, two proper courses are open when the active supervision of all utilities is undertaken. Either a new and separate commission should be created, as in Massachusetts, to direct, we will say, the operation of gas and electric companies, or the existing commissioners, whatever their political claims to office may be, should be retired, and men of ability and experience should be appointed to take their places. For our part, we can see no good reason why the commissions should not include some able members of known public-utility corporate experience. A combination of strong laws and totally inefficient commissioners cannot give the public and the corporation the protection that they are entitled to have, and will lead in the end to a reaction that will be far worse than the policy of reasonable supervision at which we believe the states are aiming now very generally.

Among the laws affecting commissions which became effective last year are those in the States of Washington, Kansas, New Hampshire, Ohio, Connecticut, Nevada and New Jersey. A law was passed by the Legislature of California, but does not go into effect until 1912. The most radical of the 1911 laws was that enacted in Kansas, which makes a failure to obey some provisions of the law a felony punishable by fine or imprisonment. The New Jersey legislation is an amendment of the earlier New Jersey commission law and was passed in order to enlarge the powers of the board. The Ohio law is peculiar in that it does not give the commission authority over municipalities which furnish public-utility service. This unfairness is displayed at an early date by the fact that the city of Cleveland is threatening to engage in the business of furnishing electric light and power in competition with the existing private corporation. The lack of proper protection for the corporation in this law is a fundamental fault in the policy of that State, assuming that its public-utility regulation is based on any definite policy; this doubt is strengthened by the denial of sufficient appropriations to carry on properly the duties imposed on the commission. We cannot repeat too emphatically that if supervision is to be effective it must protect the corporation against the public as well as the public against the corporation. Laws intrusting the wide powers which the new statutes give should be so framed as to assure the fullest protection, not only to the consuming public, but also to the investing public whose capital makes it possible to create the plants that provide the service. However thoroughly we believe in the principle of regulation and urge the corporations to co-operate with the state in proper ways in order that the laws may be reasonable and just and the commissions efficient and honest, we know that the states will have to undo their legislation or policies unless they protect and invite capital investment. Since commissions are to exist, their work should meet the reasonable views of both the public and the corporations and each interest should recognize and support policies which tend to this end.

WORK OF PUBLIC-UTILITY COMMISSIONS.

DURING the past year no important precedents have been established by the older public-utility commissions. The principles laid down along somewhat broad lines in the earlier decisions are being applied in a more specific and decisive manner as time and experience have proved their worth. The decisions of the younger commissions have in general followed the early precedents established by the older commissions. The policy of each commission appears to be to make haste slowly and so to decide its cases as to promote the highest possible standards of plant development, operation and efficiency, toward the end that the best interests of utility, investor and consumer may be subserved alike. The questions of adequate service and reasonable rates are still of paramount importance. Although not all of the state legislatures have recognized the public utility as a natural monopoly in framing laws, the several commissions are united in their policy of regulated monopoly rather than unrestricted competition, and have generally refused to permit a new utility to enter into competition with an existing utility in a territory already adequately and efficiently supplied. This opinion, however, has not been held by the courts in all cases, as, for example, in the case of the Long Acre Electric Light & Power Company, decided by the New York commission, in which the decision of the commission against giving that company a competitive status with respect to the New York Edison Company was reversed by the Appellate Division of the Supreme Court.

The general tendency of the times toward the consolidation of existing electric central stations has met with a universal approval by the several commissions in all cases where the mutual interests of utility and consumer would be advanced by such consolidation, and in all cases the total capitalization of the new company has been passed upon before authority has been granted. On the other hand, the evils of high operating costs, extravagant investment and over-capitalization which may attend the exercise of control by a holding company have been recognized by the commissions and an increasing vigilance has been evidenced in all investigations of this question. In the case of the North Adams Gas Light Company, decided by the Massachusetts Gas and Electric Light Commission, it was pointed out that this control was responsible for the high price of the company's products. This condition was due very largely to the excessive sums paid by the North Adams Company to the holding company for engineering services, salaries of executive officers and supplies purchased through the holding concern, with the result that the charges were increased beyond what they would have been had the company been conducted as an independent concern. In the same connection the Wisconsin commission found in the Beloit Gas & Electric case that the consumers had been paying interest upon a capitalization which included an item of over $300,000 for "promotion expenses" and also upon an obviously extravagant plant investment. This investigation disclosed the fact that the ultimate capacity of much of the station equipment and distribution system would not be reached, even with a very liberal allowance for future growth, until long after the period of useful life was ended. These excessive costs and values, as in the North Adams case, were, however, liberally discounted in arriving at a reasonable basis for rates, and in each case the rates were reduced. A significant decision, and one in keeping with a broad policy of public-utility regulation, was the decision by the Wisconsin commission in the case of the Pewaukee-Sussex Telephone Company, where the commission put a premium upon excellent service and reasonable rates, combined with a very economical management, by permitting the company to enjoy a 12 per cent rate of return upon its investment.

As to certain elements which should properly be classed as a capital charge, there seems to be difference of opinion. The New York commission has held in the Queens Borough case that going value, for instance, ought to be classed as an operating expense and gradually written off through a period of years. It might be stated in this connection that in the majority of cases this principle has evidently been followed by the more progressive utilities, since no reliable evidence has been introduced at any hearing to show that the early deficiencies had not been thus taken care of. The Wisconsin commission, while holding that going value should be classed as a capital charge, has applied this principle only in determining whether or not a public utility was entitled to an allowance for going value and has not applied it directly in any specific instance. The commissions seem to be divided upon the principle of allowing utilities to enjoy the benefits of an appreciated land value. It is difficult to see why, in equity, a public utility should not enjoy the same privileges as are accorded any other commercial concern, especially if such increases in real estate reflect the general tendency of the times and location and are not local or abnormal. Viewing this principle from an economic standpoint, there does not seem to be any reasonable ground upon which to deny any public utility the benefits from such an increase.

The question of rates and the best forms of rate schedules are still unsettled issues. Two facts, however, have been pretty well established, namely, that a rate schedule which approximately follows the cost of service and which differentiates between the different classes of service seems to give the best satisfaction where it has been applied by commission authority, and that the residence-lighting business, if properly developed, is one of the utility's best sources of revenue. It has been amply demonstrated by the cases in Wisconsin that the residence-lighting business responds very naturally and in a very striking manner to this form of rate schedule, and will result in a marked increase in consumption and net revenues with but a small increase in connected load. During the past year the state legislatures have not materially extended the powers of the older commissions except in Wisconsin, where the last Legislature placed all water-powers under state regulation and under the jurisdiction of the Wisconsin commission. The various state laws for the control and regulation of public utilities are very similar; and as the different elements of the law and the precedents already established receive the judicial stamp of approval, it is to be expected that the public-service commissions will in the future become more and more efficient in fulfilling the purposes for which they were created.

A. I. E. E. Meeting in New York.

At a meeting of the American Institute of Electrical Engineers to be held on Jan. 12 Mr. Percival R. Moses will present a paper entitled "Some Notes on Isolated Plants." At 10 o'clock p. m., following the discussion of this paper, a smoker will be held in the Institute rooms on the tenth floor of the Engineering Societies Building.

EDISON ON STATUS OF INVENTORS.

In a "New Year" interview printed in the *New York Evening Journal* Mr. Thomas A. Edison says:

"The worst thing about 1912 is the number of hoggish men it will have to tolerate—men, I mean, who are so greedy that they'll starve an inventor so hard he can't work. That's just what we suffer from now. The inventor can't produce. Why, there is no end—absolutely no end—to the things that 1912 could produce to make life easier and better and happier. But the inventors can't produce. They're starved down. The men that handle their inventions starve them. That's why the greedy men are the year's worst blight. That's why 1912 won't do anything near what it might be able to do in producing things for the world's good.

"What should we do this year? Jack up the man who produces—the man who works. That is, support the man and make his job easier. I tell you there is something wrong—deeply, sadly, fundamentally wrong—with our social system when so many greedy men ride the backs of the men who are the producers. The men whose opinions of 1911 I thought best of were the men who can produce. Jack up that kind of man. That's the year's best message."

WISCONSIN ELECTRICAL ASSOCIATION.

The annual meeting of the Wisconsin Electrical Association will be held in the clubroom of the Pfister Hotel, Milwaukee, Wis., on Jan. 18 and 19, 1912. An unusually attractive program has been arranged for this meeting. It will include among other features the presentation and discussion of the following papers:

Workmen's Compensation Law, by Mr. C. H. Crownhart, chairman of Industrial Commission of Wisconsin, Madison, Wis.; *Industrial Insurance from the Standpoint of the Public Utility*, by Mr. P. H. Korst, general manager Janesville Electric Company; *Latest Development in Electric Heating and Cooking Devices*, illustrated by moving pictures, by Mr. J. D. A. Cross, General Electric Company; *Floods of 1911 and Their Lessons*, by Prof. Daniel W. Mead, Madison, Wis.; *Power Solicitation in a City of 20,000*, by Mr. A. E. Peirce, assistant manager Chippewa Valley Railway, Light & Power Company; *Review of Recent Legislation Affecting Public Utilities*, by Mr. Arthur W. Fairchild, Milwaukee; *The Work of a Chief Accountant of a Public Utility in a City of 20,000 People*, by Mr. F. J. Maxwell, auditor Eastern Wisconsin Railway & Light Company; *Dispatching and Handling Street Cars and Train Crews*, by Mr. Edward J. Hammett, Sheboygan Railway & Light Company; *Electric Utilities, Financial Results, Benefit to Communities, Problems, Factors in Electric Service Rates, Methods Used to Increase the Sale of Electric Energy, Municipal Ownership Features*, by Mr. C. N. Duffy, comptroller Milwaukee Electric Railway & Light Company; *Improvements in the Art of Street Illumination*, by Mr. W. D'A. Ryan, General Electric Company; *Recent Electric Railway Developments*, by Mr. J. L. Davis, Westinghouse Electric & Manufacturing Company; *Relative Merits of Single-Phase and Multiphase Distribution of Power for Relatively Small Installations*, by Mr. E. H. Cheney, Wagner Electric & Manufacturing Company; *The New Cold Spring Shops of the Milwaukee Electric Railway & Light Company*, by Mr. R. H. Pinkley, superintendent of buildings, Milwaukee Electric Railway & Light Company; *Commercial Development of the Central Station Business*, by Mr. Egbert Douglas, sales manager Milwaukee Electric Railway & Light Company; *The Relation of Central Stations to the Wiring and Supply Business*, by Mr. W. B. Voth, chief engineer Sheboygan Railway & Light Company.

THE COPPER SITUATION.

Instead of a halt in the rising price of copper, the upward movement that began in October was continued up to the last day of the year, when the Calumet & Hecla Mining Company raised its price to 14½ cents. In the closing month of the year the average electrolytic price was 13.78 cents, as against 12.81 cents in December, 1910. The opening price of 12.29 cents in January, 1911, is to be compared to the price of 14¼ cents to 14½ cents now prevailing. The belief that owing to the general industrial situation the high-price movement of the past two months could not be maintained appears to have disappeared from the minds of those who speak authoritatively in regard to the copper market.

Nineteen hundred and eleven opened with stocks of 122,030,000 lb. in the United States and 161,720,000 lb. in foreign stocks, making a total world stock of copper of 283,750,000 lb. On Jan. 1, 1912, the United States stocks totaled only 89,785,000 lb., while the foreign stocks had decreased to 104,000,000 lb., making the world stocks 193,785,000 lb., a decrease of 90,000,000 lb.

Estimating the returns for December, it appears that 1911 will show an output of about 1,427,000,000 lb., or 25,000,000 lb. less than 1910. The domestic deliveries will apparently show a decrease of 35,000,000 lb. as compared with 1910, but this is offset by an increase of 23,000,000 lb. in exports.

The change in the situation amounts to this—that, based on stocks on hand, the apparent disposition of the producers and the probable demand of the consumers, there is little prospect of lower copper prices in the next three months and there are a number of indications that the prices may go above the present quotations. Where this view differs from that which has been held in many quarters is that the actual trade situation—rather than a supposed speculative movement and a disposition to restrict the output—is in control of the market.

Extension to New Haven Single-Phase System.

It has been announced officially that the New York, New Haven & Hartford Railroad will extend its electric zone from Stamford to New Haven, a distance of 41 miles. Use will be made of the 25-cycle, single-phase overhead catenary contact system operated at 11,000 volts, similar to that now under construction on the Harlem River branch of the road and on the New York, Westchester & Boston line. Work of construction on the overhead system will be begun within the next six months and completed in about one year. For the present and until the line is extended beyond New Haven all energy for train operation will be supplied from the generating station at Cos Cob. With the extension completed the electric locomotives will cover a total distance of 75 miles between New York and New Haven, and will completely supersede the steam locomotives for both freight and passenger service throughout this zone.

CENTRAL-STATION RATES.

In 1911 the rate research committee of the National Electric Light Association, under the chairmanship of Mr. John F. Gilchrist, now president of the association, outlined an important work with the object of encouraging uniform methods of rate making throughout the country and eventually uniform rates as far as practical. A report was submitted at the annual convention of the association, in which the following recommendations were made for residence rates:

"*Fair Return.*—Your committee is of the unanimous opinion that the charges as a whole should be no more than sufficient to pay expenses plus a profit high enough to attract capital into the central-station business. This, however, does not mean that each customer should necessarily pay the same profit or give the same return on his portion of the investment as every other customer, so that a so-called maximum rate with the customary minima for meter rent, break-down service, etc., will be entirely proper, especially when demanded by public opinion, even if some particular customers are served at an apparent loss.

"*Minimum Charge.*—The committee is unanimous that any rate should include a minimum charge per month or per year.

"*Differential.*—The committee is by no means unanimous as to whether a differential for residence business is desired, but is unanimous that if this is adopted either a plain wholesale or a differential basis on hours' use of maximum demand, or its equivalent, is the best.

"*Floor Area.*—Your committee is of opinion that floor area is the simplest, fairest, cheapest and most practical, constant and easily understood method of determining such a differential, although your committee has no recommendations to make as to whether this should be used directly or reduced to the number of rooms."

The committee for 1912 is now at work upon additional recommendations which will be issued in its 1912 report, but if any central stations are contemplating a change of rates to become effective before the 1912 convention the committee will be glad, through its secretary (Mr. W. J. Norton, 120 West Adams Street, Chicago), to offer its suggestions and advice to such companies in order that they may get the benefit of the work of the committee.

Many of the companies, realizing the importance of the work, have nominated one of the officers to act in co-operation with the rate research committee. Companies that have not made such a nomination are invited by the committee to send in the name of one of their officers to act as an assistant to the rate research committee during this year.

Circuit-Breaker Patent Decision.

Judge Hand, of the United States District Court sitting in Boston, has rendered a decision denying a charge of infringement against the Condit Electrical Manufacturing Company, of Boston, relating to Patent No. 633,772, granted Sept. 26, 1899, to G. Wright, of Wilkinsburg, Pa., on an automatic circuit-breaker. The court held that the Patent Office during the course of its proceedings with respect to the application rejected a very specific claim reading directly upon the disclosure, and yet subsequently allowed a much more general claim without change in the specifications, the result being that a claim verbally adequate does not cover the only disclosure shown in the patent. The court stated that it was prepared to hold that there consequently was no infringement, but proceeded to examine other defences, and finally held that even if the examiner were wrong in his estimate of patentability, and if the claims be infringed, yet the claims in their broad construction are void. In conclusion the court said that, if the patentee be forced to rest upon what he got, his patent has neither novelty nor has it had any success. "Of course I might make the claim a 'nose of wax' to be twisted in any way which will save the patent, but that no one thought to do, and without that the suit must fail."

ANNUAL MESSAGES OF GOVERNORS TO LEGISLATURES.

GOVERNOR DIX OF NEW YORK.

Governor John A. Dix of New York called attention to the situation created by the decision of the Court of Appeals declaring the workmen's compensation law of 1910 unconstitutional. There should be no hesitancy about taking such steps as may be necessary to secure to the working population the protection of an effective, yet rational, compensation law.

On the subject of conservation the Governor said that the problems involved in conserving the resources of the State for the benefit of the public are in some cases simple, but in others, particularly along the line of hydroelectric development, they are new and complicated, both mechanically and in their legal aspect, and warrant the most comprehensive policy possible to make the resources effective agents for the benefit of the people. Conservation of the waters on the high levels must be understood to embrace ownership or power of control and regulation by the State, and this should be accomplished without adversely affecting the existing interests. Legislation which shall recognize and conserve the interests of the people, with due regard for the rights of private business, will receive the approval of all citizens. Hydraulic energy is a most important factor in the growth and prosperity of the State. Hydroelectric power created by the construction of internal improvements, such as the barge canal, should be used to invite industries to locate along the line of the canal. Stream regulation will enable the impounded water to be utilized for power to be disposed of upon terms that will insure adequate and just revenue to the State and encourage the development of industries. The development of new powers, if utilized to their full capacity, would create in the State a system for supplying electric current to every municipality, which will mean a saving to the people of the commonwealth of 20,000,000 tons of coal per annum. There is a possibility of developing from latent energy not at present utilized 1,500,000 hp, which can be distributed through feeders along the line of the Erie Canal and the Champlain Canal, with a loop extending through the southern tier of counties—sufficient energy to create in perpetuity the power now supplied by the annual consumption of 20,000,000 tons of coal.

Governor Dix calls attention to the recent decision by the Court of Appeals, that in effect the public service commissions have very limited control over the capitalization of successor or reorganized corporations incorporated pursuant to the provisions of Section 10 of the stock corporation law. An amendment to the public service commission law designed to place the capitalization of such corporations clearly within the regulative power of the commissions, to the end that the stock and bond issue shall be limited to the fair and reasonable value of the property taken over, but leaving the distribution thereof, as heretofore, to agreement between the various interests, will be submitted to the Legislature, and its speedy enactment into a law is recommended.

GOVORNOR POTHIER OF RHODE ISLAND.

Governor Pothier of Rhode Island calls attention to the development of the policy of state regulation in various states, and to his recommendation a year ago that such a

board be established in Rhode Island. He believes that the public service corporations in Rhode Island realize from their own experience the useful purpose that would be served by some medium through which the general public could be reached, its wants better understood and its demands complied with. The General Assembly should institute such a department and clothe it with power to undertake the adjustment of differences between corporations and the public as to the service rendered and the charges imposed, and with authority to make recommendations for the improvement or extension of that service, such recommendations to carry the power of enforcement, subject to reversal only by the courts. He recommends the passage of an act creating a public utilities board to have jurisdiction over all public service corporations operated as private enterprises in the State.

On the subject of workmen's compensation Governor Pothier says that Rhode Island, when it comes to the enactment of such a law, will have the benefit of much experience that has been costly to other states, and should be able to form a statute that will combine the advantages and avoid the doubtful features of all. If the General Assembly is to act upon this matter before the national conference in August, he recommends the adoption of a resolution directing the commission on uniform laws to undertake at once the preparation of a bill to give public hearings and report a suitable law at the earliest possible date.

PUBLIC SERVICE COMMISSION NEWS.

NEW YORK COMMISSION.

The commission has received a complaint transmitted by Mr. F. C. Perkins from purchasers of electricity in the city of Buffalo against the Buffalo General Electric Company, the Cataract Power & Conduit Company and the Niagara Falls Power Company regarding electricity produced and sold by these companies. The complaint states that the prices charged by the Niagara Falls Power Company to the Cataract Power & Conduit Company affect the prices charged by the latter company, which sells electric energy to the Buffalo General Electric Company, and that as a result of these relations existing between the three companies the charges made to consumers in the city of Buffalo and to the municipality itself are unreasonable. The petition requests an investigation into the relations between the three companies, the methods employed and the prices charged customers in Buffalo, to the end that such prices may be fixed to correspond with the cost of producing, transmitting and distributing electricity in Buffalo for light, heat and power. The complaint has been served upon the company and an answer required within twenty days.

MASSACHUSETTS COMMISSION.

The Cambridge Electric Light Company has filed an appeal with the Gas and Electric Light Commission against an order of the local Board of Aldermen granting the Geo. W. Gale Lumber Company permission to install an overhead circuit across a public thoroughfare for the purpose of charging electric-truck batteries. The grantee is one of the largest users of electric vehicles in the city. The case is in many respects similar to one recently brought before the board at Worcester, as a result of which the local central-station company was sustained in its contention that no private producer of electrical energy should be permitted to transmit it across the public highways, thus threatening the stability of the business of the existing public-utility organization in the heart of its territory.

A hearing was recently given by the commission upon the petition of Mayor Fall, of Malden, for an adjudication of the price of street lights as charged the city by the Malden Electric Company. City Solicitor Boutwell conducted the case of the municipality, and the company was represented by its counsel, Mr. Everett W. Burdett, of Boston. A brief submitted by the petitioner contended that the company's finances are such as to allow a reduction in price. Mr. Alton D. Adams, of Worcester, Mass., testified that the present type of alternating-current arc lamps used in Malden is incapable of giving as good service as magnetite lamps or tungsten incandescents of high power. The present lamps consume 6.6 amp and are of the series-inclosed type, the price being $96 per lamp per year, and for incandescent lamps of the 6.6-amp size $20.80 per lamp per year, on all-night service. By a contract which expired last July the price charged for arc lamps on an all-night service was $100, incandescents being billed at $23.75. No contract now exists between the company and the city. The company offered to supply service on a ten-year contract basis at a price for arc lamps of $86.40 and for incandescents of $18.72. For the company Mr. Burdett pointed out that its operation was along thoroughly modern lines of administration. He contended that the cost of conducting its affairs was reasonable, as indicated by its operating ratio, and said that the management would gladly meet the demands of the city for magnetite-arc lighting on the terms existing in Boston, if the city so desired. He said that the usual mistake of overlooking the market price of the company's securities in considering the dividend rate had been made by the petitioner. Considering the company's investment of about $119,000 in underground lines in Malden, with nearly $300,000 total to be expended there for that purpose, the company considered the price offered entirely reasonable. The hearing was closed.

The Massachusetts Railroad Commission has issued an order granting the Boston Elevated Railway Company the right to carry express matter and light freight on its surface lines. The decision is one of the most important ever issued in the State in relation to the transportation of merchandise by electricity, and insures the working out of a service in the densely populated areas of eastern Massachusetts which will probably revolutionize the carriage of perishable and other light commodities.

The Massachusetts Highway Commission has recommended to the New England Telephone & Telegraph Company that calls in excess of the minimum allowed within 8 miles radius of Boston be reduced from 5 cents to 3 cents, and the company has placed the new rates in force. About 40,000 patrons will be benefited. The reduction follows an exhaustive study of the effect of rate charges on the company's system by Prof. Dugald C. Johnson, Boston, consulting telephone expert of the commission.

The Natick Gas Light Company has petitioned the Gas and Electric Light Commission for authority to issue new capital stock to the amount of $40,000 for the purpose of paying off floating indebtedness.

OHIO COMMISSION.

The Ohio Public Service Commission is now giving special attention to the manner in which many public-service corporations have been financed in the past, and it has been found that in some cases there are large amounts of outstanding securities that contributed only a small amount of money to the construction and improvement funds, and these must be taken into consideration where applications for new issues are made. This came about under the old methods of selling bonds at a discount and giving stock as a bonus with them. Interest and dividends must be paid on the full amounts of these securities, while they have in reality contributed to the good of the corporations and the people they serve nothing above the actual cash received for them.

The commission has planned to base its action in each case upon the figures of securities at par as far as possible, but many cases have appeared in which it was forced to deviate from this course. For instance, a company requests the privilege of issuing bonds for improvements or

extensions which are shown to be necessary, but at the same time admits that a large part of its stock was given away in bonuses, and the commission is forced to allow the issue because of the necessity for improvements in the service that will be demanded by the patrons if not forthcoming at an early date. There are many such cases, and these, the commission argues, only go to show the slipshod method of financing that prevailed in the past.

Under the rules of the commission all new corporations will be required to sell their securities at par, and every dollar thus realized will go into the construction and will thus not only insure a safe basis of operation for the companies, but will form the basis of estimating rates for the service. Under the old plan service rates must now take into consideration the securities which were given away or sold at a discount as well as those which brought dollar for dollar.

It is probable that the commission will ask the next Legislature to enact laws that will require all securities of new public-service corporations to be sold at par. The members believe that this will be much better than a rule of the commission. There are companies at present that cannot sell their securities at their full value because of the manner in which they have been financed. The commission hopes, however, that within a few years the same rule may apply even to these. It is believed that they can be put upon a footing that will be recognized in financial circles as sound, and that there will be no trouble in securing funds then.

It has been found that the electric-railway companies have been the transgressors in many cases of over-issue and stock bonuses. These cases are being handled with care, and the commission feels that most of them will yield to proper adjustment in time. But it may be said that some of these companies are in most excellent shape and that they are managed with as much skill as the best steam lines.

The city of Tiffin has filed an answer with the commission to the petition of the Tiffin Consolidated Telephone Company, in which the latter protested against the rates fixed by the City Council recently. The answer states that a material increase in rates followed the consolidation of the Central Union and the Independent Home Telephone systems in that town. The rates for individual-line business service were advanced from $2.50 per month to $3.50, and for party-line business service from $2 to $3 per month. Residence service was increased from $1.50 to $2 per month. The petition states that the Council attempted to adjust these rates, and the company followed with a petition of protest to the commission. The Circuit Court has since handed down a decision to the effect that a city council has no authority to fix rates.

Because the Cincinnati & Suburban Bell Telephone Company failed to file its rates with the commission until Dec. 21 its patrons using nickel-in-the-slot instruments on the basis of 10 per cent of the earnings of the telephones will not be able to take advantage of the new commission rate of 20 per cent until Jan. 21. So far as the company is concerned, this contract could have gone into effect the first of the year, but the commission insisted that the full thirty days must elapse before the new rate could go into effect.

WISCONSIN COMMISSION.

In the case of the Juneau Electric Company, in which it was alleged that the New Lisbon Mutual Telephone Company had so constructed its telephone line as to interfere with the service rendered by the petitioner, the commission has ordered both companies to co-operate immediately in the improvement of their respective systems to the end that all subsequent interference may be avoided. Following a policy rigorously adhered to in the past, the commission refused to consider any application for an increase in rates until the petitioner's service and wire plant were put in satisfactory shape. The investigation carried on by the engineering staff showed that the Juneau Electric Company had recently increased its rates in all cases where a call had to be transmitted through more than one exchange. As a result a number of dissatisfied subscribers, who desired cheap service under the delusion that cheap service was good service, organized the competing defendant company. Whether from malice, as it was alleged, or from ignorance, an improper method of construction was employed and the proximity of the two systems led to troublesome interference. This difficulty was augmented by the dilapidated condition of the petitioner's wire plant.

After a hearing and an extended investigation, the Battle Island Company has been authorized by the commission to issue $100,000 par value of stock for the purpose of acquiring a dam site and 3500 acres of flowage land on the Wisconsin River, near Knowlton, in Marathon County, Wis. A portion of the funds to be derived from the sale is to be used in defraying organization and engineering expenses. The company proposes to erect a hydroelectric plant and to develop a minimum of 2300 electrical hp. The transmission line is to extend 72 miles to the city of Neenah, and it is intended to supply the cities of Oshkosh, Fond du Lac and Neenah.

The commission has authorized The Milwaukee Electric Railway & Light Company to issue $4,000,000 par value of 5 per cent general and refunding mortgage bonds, to be secured by a mortgage executed by the applicant to the Bankers' Trust Company of New York as trustee. This issue was authorized for the purpose of enabling the company to pay an outstanding indebtedness incurred by reason of additions and extensions to its property during the years 1910 and 1911, and to provide for future extensions and additions. It was further ordered that the certificate authorizing the issue of $2,000,000 of refunding and extension mortgage bonds, dated Sept. 28, 1911, be amended so as to authorize the company to sell or pledge this previous bond issue.

In the matter of determining and fixing the just compensation to be paid by the city of Kaukauna for the property of the Kaukauna Gas, Electric Light & Power Company, the commission has determined that $50,000 is a fair and reasonable price under the circumstances. The first tentative valuation fixed a reproductive cost of $63,304 and a present value of $47,320. In a previous hearing on the question of service rendered by the respondent company it was brought out that the company's inability to comply with the commission's prescribed rules of service was largely due to the fact that certain power-plant machinery and a portion of the distribution system were considered inadequate. The company, in agreeing to bring the service up to the standard required by the commission, made certain proposals for the rehabilitation of the property to enable it to meet service demands. The city contended that all items of property which were to have been replaced in the proposed improvement should be excluded from the property used and useful. In the commission's revised present valuation of $44,992 this contention was given due weight. No consideration was given the company's claim that certain contracts with large power users should be regarded as assets, for the reason that analysis showed that service was being furnished at cost. Neither, in the commission's opinion, could the present water-power lease be considered as an asset; for the total cost of the water-power, all elements included, was not far from what the cost would be if the power were generated by steam. By using the commission's method for determining the existence of going value the company sought to show that the property was worth at least $79,235. No consideration was given this contention, for a detailed analysis of the company's past condition revealed the fact that after the first three years of operation the earnings were more than sufficient to take care of an 8 per cent interest charge and a

5.72 per cent depreciation charge. Subsequently, however, through controversy and mismanagement, the operating expenses increased at a much greater rate than did the operating revenues. Therefore the losses which occurred were not incurred in building up the business, but were due to poor and inefficient management and as such could not be considered as an element of going value. Furthermore, in arriving at the figure presented, the defendant failed properly to distinguish between maintenance and capital charges. After a careful consideration of all facts in the case, the commission was of the opinion that $50,000 represented a fair and equitable compensation for the defendant's property and thereby ordered this sum to be paid within six months. The material on hand at the date of taking possession and any new additions made since Jan. 30, 1911, are to be paid for by the city at a price to be agreed upon by the parties, or, such agreement failing, the price will be fixed by the commission.

This is the first case of any importance to come before the commission where a municipality has exercised its right of purchase under the law. In this case the action was provoked by years of friction and controversy between the city and the utility, which resulted in a large measure from the poor and inadequate service rendered by the defendant.

MARYLAND COMMISSION.

The telephone rate case, frequently referred to in this column, was decided last Saturday by the Public Service Commission in an opinion written by Chairman Ambler. The principal points in the decision are that the Chesapeake & Potomac Telephone Company, which in August, 1910, submitted a new schedule of rates, will have to adopt a satisfactory registering device before doing away with the unlimited service, and that the subscribers shall have the option of a coin-box telephone in place of the registering device. The commission has also brought about some reductions in the rates proposed under the company's schedule. The question as to what is a fair return on telephone property is taken up, and in this connection the decisions of the commissions of Wisconsin and of the First District of New York are referred to as having been used as authorities. It is declared that 8 per cent is a fair return on a telephone property and that 6 per cent is a fair allowance for depreciation. The difference between the old and the new conditions in the telephone situation in the city of Baltimore are discussed, and it is shown that, while there are a certain number of subscribers who pay for service at the old rates, these are getting an advantage over those who made contracts later. It is stated that as the result of the inquiry of the commission's engineer it was shown that the flat-rate service cost the telephone company from $35,000 to $40,000 more a year than the company received for it, and it is declared that the subscribers who pay for the message rate service have to meet this cost in the rates they pay. The opinion states that the company should establish a system of registering the calls of subscribers that shall be as accurate as possible, and this includes a registering device on the subscriber's telephone. The company, it is stated, has adopted a register and is now in a position to manufacture it in sufficient quantities to meet the situation. It is said that the register has not yet passed the experimental stage, and in this connection the commission reserves the right to order the installation of a new device if that first put in proves satisfactory. In the proposed rates the commission has brought about reductions of about $3 a year in the schedule covering from 600 messages a year to 3000 messages a year. Beyond that there is no reduction from the proposed schedule. It is declared that there is a saving of over $40,000 a year to 4454 subscribers in this particular schedule. The order of the commission is to remain in force for three years from May 1 next, and it is further ordered that the flat-rate service may be discontinued after Oct. 1, 1912, the subscriber to get the option of a meter or a coin-box service.

As the telephone company, through coin boxes and pay stations, established 5 cents as the standard rate for local messages, the commission states that it was strongly inclined to insist upon that being the maximum rate for all subscribers; but, considering the advantages derived by the subscribers through having a telephone at hand and through the advertisement received from having their names in the directory, the commission decided that a small extra charge should be imposed.

Current News and Notes

INDIANA ENGINEERING SOCIETY.—The annual meeting of the Indiana Engineering Society will be held at the Denison Hotel, Indianapolis, Jan. 25 to 27, 1912. The annual banquet will be held on Friday evening, Jan. 26. In connection with the convention there will be an exhibit of articles or products of engineering interest. Mr. Charles Brossmann, Union Trust Building, Indianapolis, Ind., is secretary.

* * *

CENTRAL-STATION BUSINESS IN 1911.—In a pamphlet issued by Kountze Brothers, the New York bankers, of which Mr. Robert T. Lozier is the author, an estimate is given of the growth of commercial central-station business to date from the time of the last United States Census in 1907. The gross income for 1911 is estimated at $334,574,800, an increase of 107 per cent over 1907; total expenses, $200,744,800, an increase of 107 per cent; net income, $133,829,920, an increase also of 107 per cent.

* * *

N. E. L. A. TRAIN DE LUXE.—According to the New York *Sun*, railroad officials are now working on an order from the National Electric Light Association for transportation service in connection with the convention of that body next May and June in Seattle. It is stated that the order covers forty Pullman cars and involves a revenue to the railroads of between $70,000 and $80,000. The service will be similar to that arranged for the meeting of the American Bankers' Association in New Orleans in November. The cars, which were first used by the bankers, are of steel construction throughout, providing wider aisles, larger rooms, longer and higher berths, spacious vestibules, mahogany-finished woodwork, individual electric reading lamps in each berth and electric fans in every room. On each train during the New Orleans trip were ladies' maids, barbers, valets, stenographers. At every stop telephone communication was made and long-distance as well as local calls were possible. The morning papers of each town passed through were on the train. The latest magazines and periodicals were in the rooms set aside for the so-called "clubs" of men and women, the ladies' club being the observation car, where afternoon tea was served daily. There were concerts on board every evening after dinner by professional talent supplemented by the talking machines and mechanical pianos. Bridge, poker and other card games had their special rooms. Each of the sections consisted of a baggage car, a buffet, a library or club car, two dining cars, one twelve-section drawing-room-stateroom car, three seven-stateroom and double drawing-room cars, one ten-room compartment car and one six-stateroom observation car. The breakfast menu included forty-one items, exclusive of breads and beverages, and the luncheon and dinner cards were correspondingly elaborate. As an indication of the care given to details, each patron received daily a washcloth hermetically sealed in a sanitary covering, on which his or her name was printed.

CLEVELAND ENGINEERING SOCIETY.—On account of the holidays the Cleveland Engineering Society held no regular semi-monthly meeting Dec. 26. The next meeting, scheduled for Jan. 9, will be addressed by Mr. C. E. Denney, signal engineer for the Lake Shore & Michigan Southern Railroad, on the subject of "Railway Signaling." A general invitation is extended to visitors.

* * *

ELECTRICAL SECTION OF WESTERN SOCIETY OF ENGINEERS.—Nominations for the officers of the Electrical Section of the Western Society of Engineers (Chicago) for the year 1912 have been made as follows: Chairman, Mr. P. B. Woodworth; vice-chairman, Mr. James Lyman; new member of executive committee, Mr. G. T. Seely. The nominations are usually equivalent to election.

* * *

AMERICAN ASSOCIATION FOR THE CONSERVATION OF VISION.—Officers of the A. A. C. N. recently elected are as follows: President, Dr. F. Park Lewis; vice-president, Mr. E. L. Elliott; acting secretary, Mr. Douglas C. McMurtrie; acting treasurer, Mr. T. Commerford Martin. The offices of the association have been moved from 29 West Thirty-ninth Street to 105 East Twenty-second Street, New York.

* * *

SPRING CONVENTION NEW ENGLAND N. E. L. A. SECTION.—The annual meeting and convention of the New England Section of the National Electric Light Association will be held at the Hotel Kimball, Springfield, Mass., on Thursday and Friday, March 14 and 15, 1912. Plans are being formulated for the presentation of five papers. Miss O. A. Bursiel is secretary, with permanent offices at 149 Tremont Street, Boston.

* * *

LARGEST STEAM TURBINE IN NEW ENGLAND.—In the issue of Dec. 23, page 1546, it was stated that the newly installed 15,000-kw turbo-alternator in the Boston Edison station was the largest in New England. Since the Boston unit was installed the Rhode Island Street Railway Company has put in operation in its power station, in Providence, a 20,000-kw unit, which has been in regular service about seven weeks up to the present time.

* * *

HIGH-HEAD WATER-POWER PLANT IN OHIO.—A hydroelectric development with a head of 102 ft. is now under construction at Akron, Ohio. Approximately 2000 kw will be produced by water-power, in addition to a larger rating of steam-plant capacity which is also being installed. The water-power portion is expected to be completed by the fall of 1912. The hydraulic head under which the new plant will operate is the highest in Ohio, if not in any of the Central States.

* * *

CAMBRIDGE SITE ASSURED FOR MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—Mayor Barry, of Cambridge, Mass., has signed an order abolishing Amherst Street and turning over the land occupied by this thoroughfare on the border of the Charles River to the Massachusetts Institute of Technology. This step insures the final location of the Institute upon a magnificent site on the Charles River Basin in the heart of the Boston metropolitan district, between Harvard and the West Boston bridges and immediately opposite the Back Bay.

* * *

ANNUAL DINNER OF ENGINEERS AT BOSTON.—The third annual dinner of the Boston sections of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the Boston Society of Civil Engineers will be held at the Hotel Somerset, Boston, on Jan. 15. Among the speakers will be President Maclaurin, of the Massachusetts Institute of Technology; President Hamilton, of Tufts College; General Hugh Bancroft, chairman of the Directors of the Port of Boston, and representatives of the national engineering organizations.

* * *

DECORATIVE STREET-LIGHTING COMMITTEE.—Chairman Hodge has called the first meeting of the committee on decorative street lighting and electrical advertising of the Commercial Section of the National Electric Light Association. It will be held in Chicago on Jan. 17, and the work of the committee will be outlined. The committee consists of Messrs. W. H. Hodge, Chicago; Henry Schroeder, Harrison, N. J.; T. G. Whaling, Bloomfield, N. J.; Claude Bender, Cleveland; A. Larney, St. Paul; C. L. Eshleman, Cleveland, and B. W. Mendenhall, Salt Lake City.

* * *

BOSTON EDISON COMPANY TO REDUCE RATES.—The Edison Electric Illuminating Company of Boston will reduce its maximum net rate from 11 cents to 10 cents per kw-hour, beginning with March 1. The reduction is the fourth of its kind since June, 1906, when the rate was 18 cents. The forthcoming decrease has been under consideration by the officials of the company at the suggestion of the Massachusetts Gas and Electric Light Commission since September. It is anticipated that the immediate effect will be to reduce the bills of the company's customers by about $200,000. Those paying the maximum net rate constitute about 75 per cent of the total.

* * *

JOINT MEETING OF CONTRACTORS IN CHICAGO.—The semi-annual meeting of the Electrical Contractors' Association of the State of Illinois will be held at the Hotel Sherman, Chicago, on Feb. 2 and 3. Meeting jointly with the state association will be the Chicago Electrical Contractors' Association and the Faraday Electrical Association. There will be a closed session on Friday morning, Feb. 2, and an open meeting in the afternoon. On Saturday afternoon there will be an open meeting with an unusual feature. Fifteen-minute speeches will be made on any subject connected with electrical contracting. For the best three speeches prizes will be awarded as follows: First prize, $125; second prize, $100; third prize, $75. The prizes will be awarded by vote of the assemblage, and any member of the three societies may compete. In the evening there will be a banquet. Mr. Ernest Freeman, 538 South Dearborn Street, Chicago, may be consulted in relation to the arrangements for the convention.

* * *

FEDERAL SUPERVISION OF CORPORATIONS.—Secretary Nagel, of the Department of Commerce and Labor, in his annual report to President Taft, declares that the Sherman law has proved to be an effective statute and that a degree of combination of capital is necessary, but that the Supreme Court decisions in the trust cases have demonstrated that the next step in the control of great industrial corporations will be the creation of a permanent federal agency. This authority should, by steady and continuous supervision and publicity, safeguard the public interests and at the same time allow full scope for necessary and proper business efficiency and development. Whether this agency shall be established by means of federal incorporation or by a federal office or commission exercising powers of regulation and supervision may be a secondary question. It would be a logical expansion of the operations and policy of the Bureau of Corporations to develop that department to take up the form of supervision suggested.

Steel Mill Adopts Central-Station Service.—The Carnegie Steel Company has closed a contract with the Allegheny County Light Company for 1000 hp to be used in an experimental way as motive power in its Painter Mill. Only part of the mill is to be motor-driven at present, and the results of operation of electric drive with central-station service will be compared with the results in the rest of the mill, where steam drive is in use.

* * *

Annual Meeting of the Illuminating Engineering Society.—The sixth annual meeting of the Illuminating Engineering Society will be held at the Machinery Club, 50 Church Street, New York, at about 8 p. m. on Friday, Jan. 12. It will be preceded by a dinner at the same place, beginning at 6:30 p. m., for which $2 a plate is the charge. At the annual meeting there will be addresses by the retiring president, Mr. A. E. Kennelly, and by the presidents and other executives of various technical societies. The results of the annual election will be announced.

* * *

Uranium Emanation.—Mr. James Warriner Moulton, who has been conducting a series of investigations at Columbia University, New York, has discovered what appears to be a change in the rate of emanation from uranium with mechanical rotation of the uranium mass. An electrostatic voltmeter receiving its charge from the electricity produced on the belt of a small motor gave an indication which varied in an irregular manner according to the extent of the mass of uranium connected inductively to an electric circuit with which it was revolved by the motor belt. The experiments thus far completed have been qualitative only, and no explanation has been offered for the unexpected results obtained.

* * *

Tests of Electric Meters in New York State.—During November, 1911, reports of 7184 tests of electric meters were made to the New York Public Service Commission, Second District. Of this number 360, or 5.01 per cent, were fast; 5976, or 83.19 per cent, were accurate, and 848, or 11.8 per cent, were slow. Of the total of 238 companies, thirty-seven did not report, and of those reporting eighty-five made no tests. During October, 1911, of 7399 tests of electric meters reported to the New York Public Service Commission, Second District, 354, or 4.78 per cent, were fast; 6226, or 84.15 per cent, were accurate, and 819, or 11.07 per cent, were slow. Of the total of 237 companies, thirty-seven did not report, and of those reporting 100 made no tests.

* * *

Use of New Code Insulated Wire Enforced.—The Rocky Mountain Fire Underwriters' Association has issued, through its electrical engineer, Mr. W. J. Canada, notice that on and after April 1, 1912, no rubber-covered wire of sizes from 14 to 1/0 will be approved by the association in any installations in the cities of Denver, Colorado Springs, Pueblo or Trinidad, except where such wire is approved, listed and labeled by the Underwriters' Laboratories from examinations and tests under the specifications for rubber-covered wire published in the 1911 National Electrical Code. The notice is sent to contractors, architects and lighting companies throughout the territory. An order to the same effect has been issued by Mr. C. L. Reasoner, city electrician of Colorado Springs.

* * *

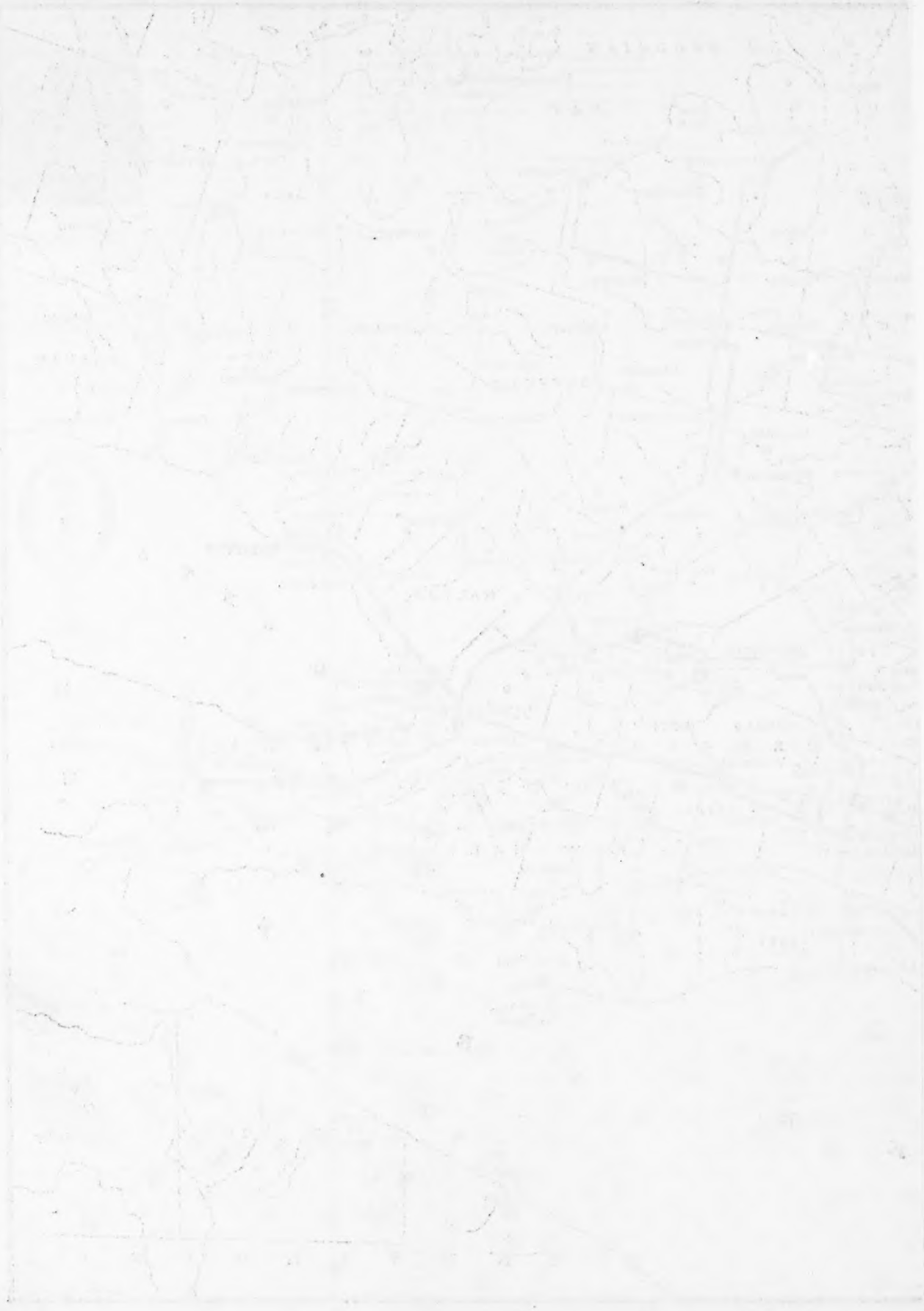
Fourteen Million Horse-Power Available in Water-Power in Rivers Draining the Great Lakes.—In an address before the Irrigation Congress at Chicago last month Prof. Gardner S. Williams, of the University of Michigan, estimated as follows the water-power available in the rivers which drain the great lakes: St. Mary's River, 170,000 hp; Niagara River, 7,000,000 hp; St. Lawrence River, 6,500,000 hp. The sum of these available outputs is equivalent to one-fourth of the power which might be developed from the total coal production of the United States as mined at the present rate, provided all this coal were burned under boilers and the steam utilized in the most modern and efficient engines. Professor Williams also commented on the claims made by the navigation interests and others, that the diversion of water through the Chicago Drainage Canal has lowered the Michigan-Huron lake level. He pointed out that in the lowering of levels and destruction of harbors navigation is itself a most active agent, for when connecting channels like the St. Clair and Detroit Rivers are dredged to deepen them the increased flow through the new opening may discharge water enough to depress the upper lake level and reduce the dredged channel to its former depth. The Michigan-Huron surface has already been lowered 8 in. in this way.

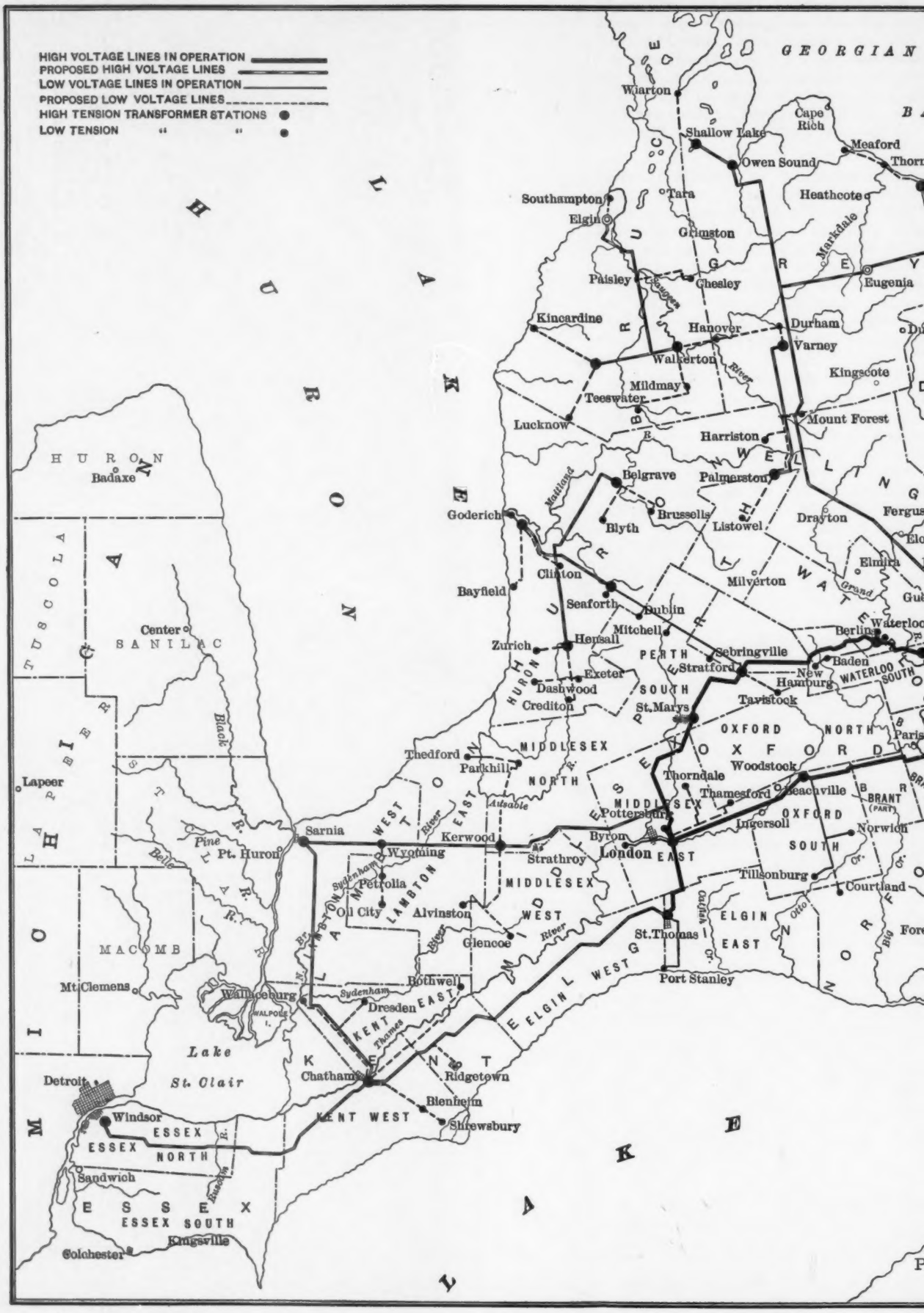
* * *

Opening of Byllesby Convention.—About 200 men attended the opening of the third annual convention of H. M. Byllesby & Company and Affiliated Companies at the Congress Hotel, Chicago, on Jan. 2. About half were from the main Chicago office and others from the various Byllesby properties all over the country, quite a delegation coming from the Pacific Coast. Mr. T. K. Jackson, of Mobile, Ala., chairman of the convention, called the gathering to order at the opening session, and then retired in favor of Mr. Henry M. Byllesby, founder and president of the company, who delivered an inspiring address of welcome, the keynote of which was that in the Byllesby organization the effort is made to raise opportunity and profit-sharing to the maximum and to reduce selfishness to the minimum. The speaker gave some striking statistical statements, including one to the effect that the various Byllesby utilities serve over 140 communities and over 190,000 customers. The responsibility that goes with public service of this diversity and magnitude is sobering, said Mr. Byllesby. Sessions of the convention, with papers and discussions, were held on Jan. 2-5, inclusive, and will be reported next week. The delegates were entertained at luncheon every day by the company, without leaving the hall, and the affair was a combination of a convention of keen electrical operating men and a large family gathering.

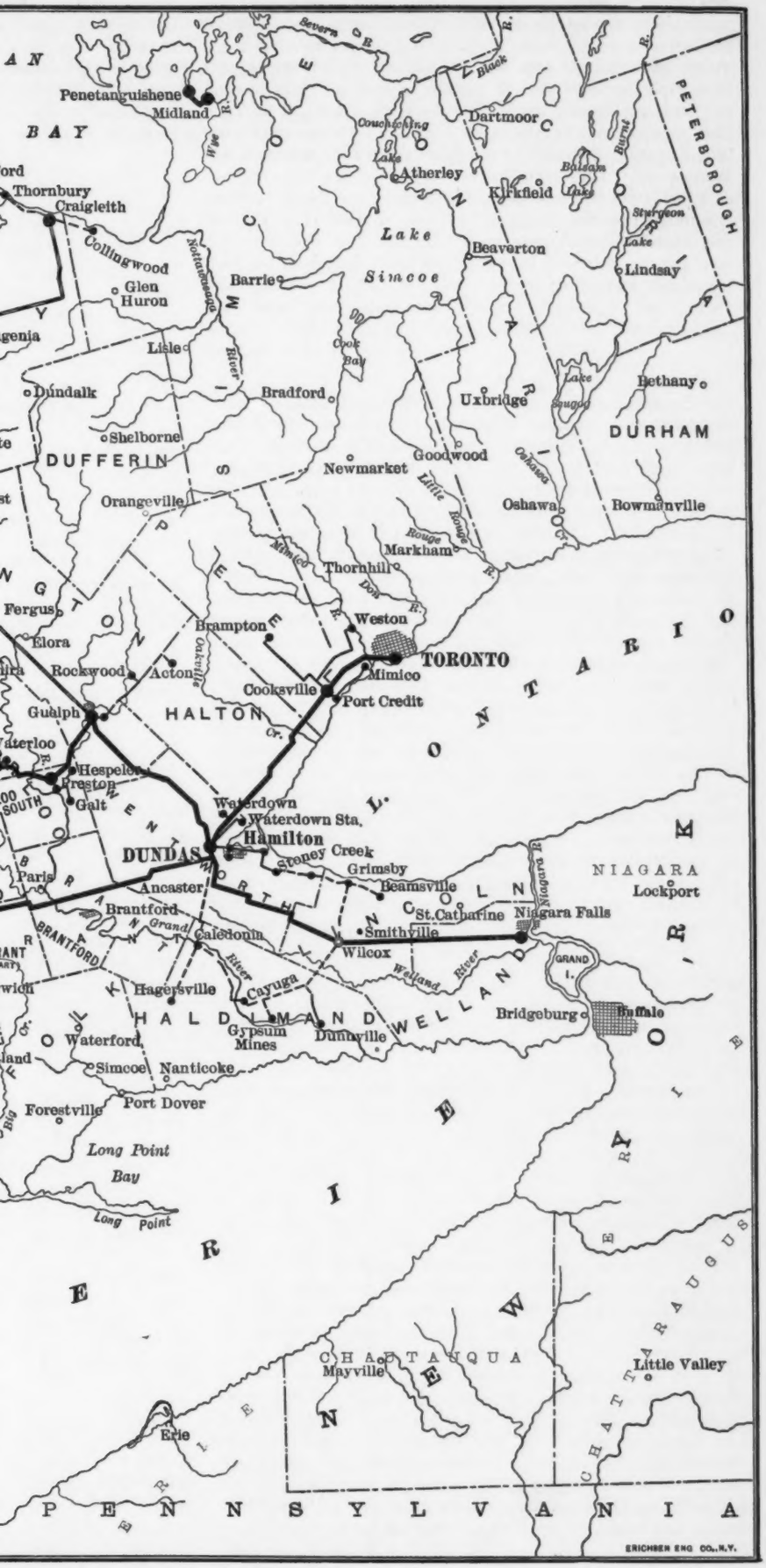
* * *

Use of Aluminum for Magnet Winding.—Aluminum is about one-fourth as heavy as copper, has a specific resistivity not quite three times as great, and naturally forms on its surface an oxide which has a comparatively high electrical resistance, so that for winding coils of the light metal no other insulation is usually needed. Abroad advantage has been taken of these properties in making magnets and field coils of all kinds, although in America less attention has been given to such construction. Several thousand railway motors are reported in service in England using aluminum field coils. For winding work the natural oxide of the aluminum surface is thickened by a corroding treatment. Even the natural oxide presents good electrical insulation, but with the thickened coating practically no electrical leakage can be discovered. For wires up to No. 16 equivalent carrying capacity aluminum is declared to have considerable space economy over cotton-covered copper wire, while in sizes above No. 16 it occupies nearly the identical volume. The entrance of moisture to such an aluminum coil does not impair the insulation, but actually tends to improve it, since a thicker coating of insulating oxide is formed. This oxide is, of course, fireproof, and withstands high temperatures without injury. An American manufacturer of large lifting magnets is now preparing to build these coils with aluminum windings. Such a magnet can be constructed with about one-third the weight and the same amp-turns and carrying capacity as the copper coil.





Map of Transmission System of Hydro-Electric Power Commis

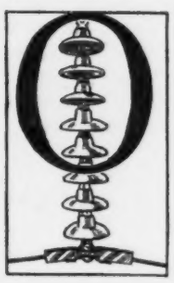


Commission of Ontario.

110,000-VOLT TRANSMISSION SYSTEM OF THE PROVINCE OF ONTARIO.

Work of the Hydro-Electric Power Commission in Distributing Electricity to Municipalities and Farmers.

Organization of the Commission—Form of the Contracts with Municipalities—General Description and Specifications of Standard Towers—Method of Erecting Towers.



ONTARIO'S great scheme for the utilization of its water-powers has been accomplished, and the most populous of the provinces of Canada has now in actual service one of the most extensive transmission systems in the world and one operating at the highest potential at present in commercial use. Two hundred and eighty-one miles of 110,000-volt lines and 180 miles of 13,200-6600-volt lines supply energy to twenty-nine municipalities at cost, and the work has been carried through to completion for less than the estimate. A complete account of the engineering features of the hydroelectric scheme is given in what follows.

GENERAL.

The Hydro-Electric Power Commission of the Province of Ontario is a government corporation which was appointed by the Provincial Legislature of Ontario in order to provide for the development, generation, transmission and distribution of hydroelectric energy at cost to the various municipalities desiring it throughout the Province. The success of the commission is due to the energy of the present chairman, Hon. Adam Beck, who has been identified with this movement since its inception, the support of the project by the public and press irrespective of politics, and the loyalty of a wisely selected engineering staff.

In order that this government enterprise may be thoroughly understood, it will not be amiss to give a concise history of its inception and development, following as it did the popular demand by the people for cheaper electrical energy for industrial, lighting and heating purposes. Owing to the fact that there are no coal mines in Ontario, the Province is dependent upon outside sources for its fuel supply. Any contingency such as a strike, the enactment of a prohibitory export law or an increase in the cost of coal would seriously affect the Province.

The rapid development of electrical apparatus, the increased popular uses of electricity and the establishment of numerous hydroelectric generating plants in the vicinity of Niagara Falls had, even as early as 1900, been closely followed by the people of the Province. Public sentiment which demanded that the Province should share in the great heritage bestowed upon it in the water-power at Niagara Falls resulted in the appointment of the Hydro-Electric Power Commission of Ontario, which is now engaged in supplying the various municipalities throughout the Province with hydroelectric energy.

Late in April, 1900, the Toronto Board of Trade appointed a committee to investigate the feasibility of transmitting electric energy from Niagara Falls to Toronto. There was some question at that time as to whether or not this proposed Niagara connection should be municipally controlled. Several meetings attended by representatives from the various municipalities, the Canadian Manufacturers' Association and the Board of Trade followed this first gathering. Numerous resolutions were later presented to the government then in power requesting the appointment of a commission to investigate the matter. The Legislature complied with this request, and in June, 1903, an act was passed authorizing any two or more municipalities to appoint commissioners to investigate and report the desirability of establishing generating plants, transmitting electrical energy for the production of power, light and heat, and the probable cost of such installations. Acting upon this authority, a meeting of representatives of seven municipalities interested was held on Aug. 12, 1903. A commission was appointed which consisted of Messrs. E. W. B. Snyder, Waterloo; Adam Beck, London; W. F. Cockshutt, Brantford, and P. W. Ellis, Toronto. This commission prepared and published on March 28, 1906, a comprehensive report.

In the meantime a new government came into power. The Hon. Adam Beck, who had previously given a great deal of time and thought to the subject, took the matter up with this government, of which he was a member, with the result that on July 5, 1905, a permanent Hydro-Electric Power Commission for the Province of Ontario was incorporated by the Legislature, consisting of Mr. Beck as chairman, Mr. George Pattinson, M.P.P., of Preston, and Mr. P. W. Ellis, of Toronto. Mr. Ellis subsequently resigned because of ill health, and Mr. John Milne, of Hamilton, was appointed to fill the vacancy. This commission made a thorough investigation of the developed and undeveloped water-power of the Province. Its report showed conclusively that not only was the transmission of electric energy from Niagara Falls to the municipalities in the Province practicable, but that this energy could be transmitted and sold at a lower rate than was at that time being charged. As a result the largest and most influential deputation that ever waited on the government in the history of the Province came to Toronto and placed its views on record. A second commission, which still holds office, was appointed in May, 1906, and consisted of the Hon. Adam Beck, chairman; Hon. J. S. Hendry, Hamilton, and Mr. W. K. McNaught, Toronto. It was invested with the powers necessary to provide for the development, generation and transmission of hydroelectric energy at cost to the various municipalities in the Province of Ontario.

CONTRACTS.

By-laws were submitted to the various municipalities throughout western Ontario in January, 1907, authorizing the various incoming councils to deal with the Hydro-Electric Power Commission. These by-laws were unanimously carried in most cases, and active steps were at once taken to obtain electric energy from the commission. At that time there were several hydroelectric power companies at Niagara. The government, through the commission, requested these companies to submit tenders for the supply of

energy to the provincial system, since it did not wish to interfere in any way with vested capital. After lengthy negotiations and careful consideration of the tenders by the commission the contract was finally awarded the Ontario Power Company.

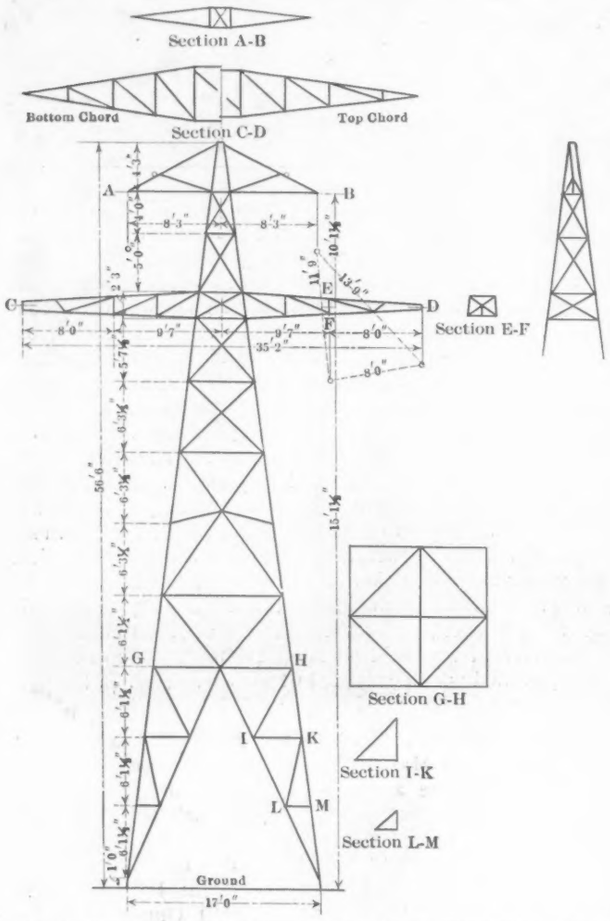


Fig. 1—Standard Double-Circuit Short-Leg Transmission Tower.

An agreement was made on Aug. 12, 1907, which required the delivery to the commission of electric energy at 60,000 volts pressure. Later, after careful investigation, it was decided to change the transmission voltage for the system to 110,000 volts. Accordingly, on March 19, 1908, a new agreement was made by which the commission agreed to take energy from the generators of the Ontario Power Company at 12,000 volts. From this voltage it was to be stepped up by the commission to the required potential for the transmission system. The price agreed upon was $9.40 per hp per annum up to 25,000 hp. When the quantity taken or reserved shall exceed this amount the price is to be reduced to $9 per hp per annum.

The municipalities of Toronto, Hamilton, London, St. Thomas, Brantford, Galt, Stratford, Woodstock, Guelph, Waterloo, St. Mary's, Hespeler and New Hamburg submitted by-laws authorizing the raising of funds to cover the cost of a distribution system for the energy purchased from the commission in January, 1908. These by-laws were carried by large majorities. Ingersoll contracted with the commission at a later date. The commission entered into agreement the succeeding May to supply energy to municipalities as follows: Toronto, 10,000 hp; London, 5000 hp; Guelph, 2500 hp; Stratford, 1000 hp; St. Thomas, 1500 hp; Woodstock, 1200 hp; Berlin, 1000 hp; Galt, 1200 hp; Hespeler, 300 hp; St. Mary's, 500 hp; Preston, 600 hp; Waterloo, 695 hp; New Hamburg, 250 hp; Ingersoll, 500 hp.

Since that date the following municipalities have contracted with the commission: Hamilton, 1000 hp; Tilsonburg, 500 hp; Brampton, 1300 hp; Weston, 250 hp; Dundas, 600 hp; Seaforth, 400 hp; Mitchell, 200 hp.

SYSTEM.

The general map shows the extent of the high-tension system as constructed. There are at the present time 281 miles of line sectionalized as shown in Table I.

TABLE I.—HIGH-TENSION SYSTEM OF ONTARIO.

Nomenclature of Sections.	Miles.	Towers.	Circuits at Present Erected.
Section A—Niagara Falls—Dundas.....	51.4	Double-circuit	2
Section B—Dundas—Toronto.....	39.1	Double-circuit	2
Section C—Dundas—Paris.....	22.6	Double-circuit	1
Section D—Paris—Woodstock.....	21.8	Double-circuit	1
Section E—Woodstock—London.....	25.4	Double-circuit	1
Section F—Dundas—Guelph.....	25.3	Double-circuit	1
Section G—Guelph—Berlin.....	19.1	Double-circuit	1
Section H—Berlin—Stratford.....	25.1	Double-circuit	1
Section I—Stratford—St. Mary's	13.5	Single-circuit	1
Section J—St. Mary's—London	23.6	Single-circuit	1
Section K—London—St. Thomas.....	13.4	Double-circuit	1

It will be noted that while two circuits are erected in Sections A and B, only one circuit is erected throughout the rest of the system. The reason for this is apparent upon examination of the general plan of the system. All the stations beyond Dundas, with the exception of Toronto and St. Thomas, are on a loop circuit and as a result may be served from Dundas in either direction around the loop. Under normal operating conditions, the direction of current flow is from Dundas to London on the south side and from Dundas to St. Mary's on the north side of the loop, the line between St. Mary's and London being held in reserve.

The main step-up transformer station is located at Niagara Falls, Ontario, where the energy, purchased from the Ontario Power Company and supplied at 12,000 volts, 25 cycles through a 2200-ft. conduit line, is stepped up to 110,000 volts for delivery to the three-phase high-tension

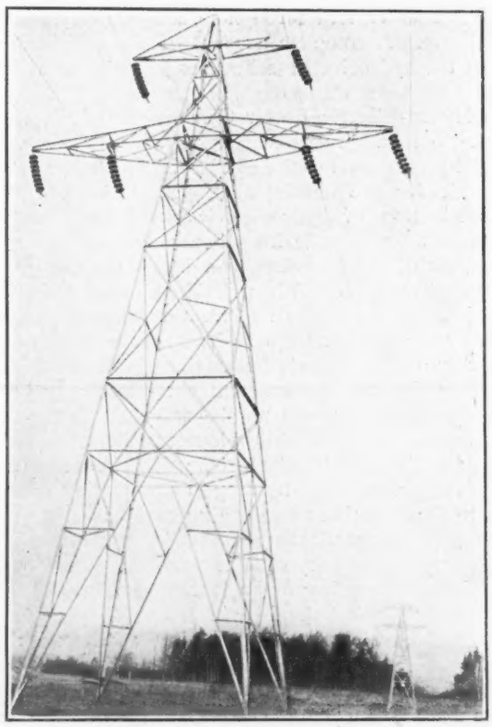


Fig. 2—Standard Tower with Two Circuits and Ground Cable.

lines. The present installed transformer capacity at this station is 27,000 kw.

The 110,000-volt pressure is stepped down to 13,200 and 6600 volts for local and low-tension distribution at the following points, the installed transformer capacity being

given for each substation: Dundas, 2250 kw; Toronto, 7500 kw; London, 3750 kw; Guelph, 2250 kw; Preston, 2250 kw; Berlin, 2250 kw; Stratford, 2250 kw; St. Mary's, 2250 kw; Woodstock, 2250 kw; St. Thomas, 2250 kw; Port Credit, 3750 kw.

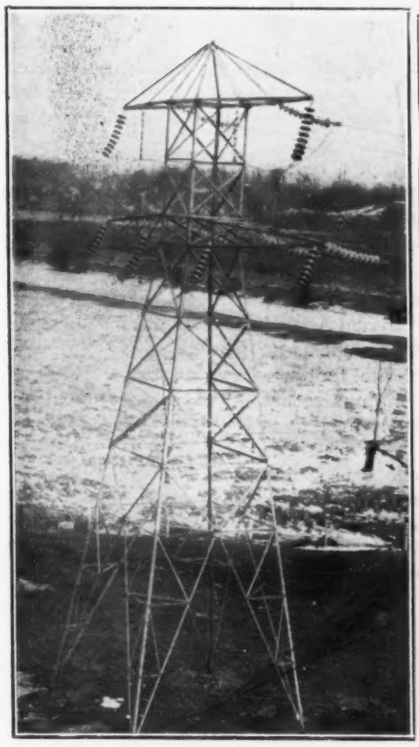


Fig. 3—Standard Double-Circuit Tower.

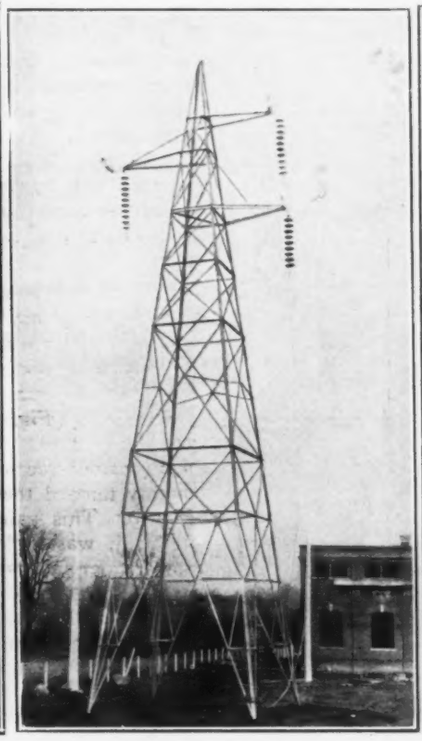


Fig. 4—Standard Single-Circuit Tower.

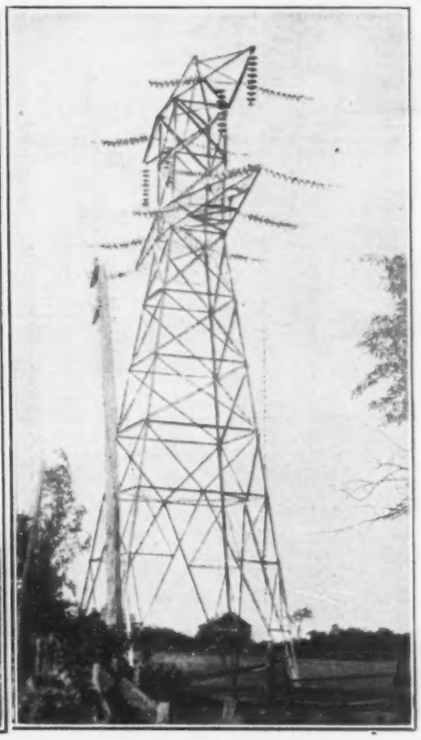


Fig. 5—Anchor Tower.

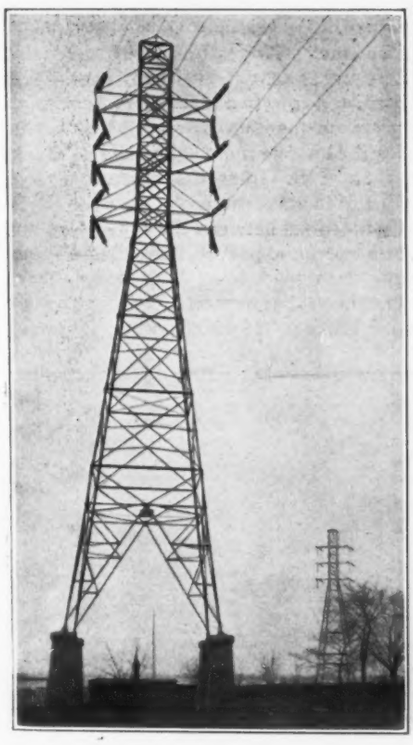


Fig. 6—Angle Tower.

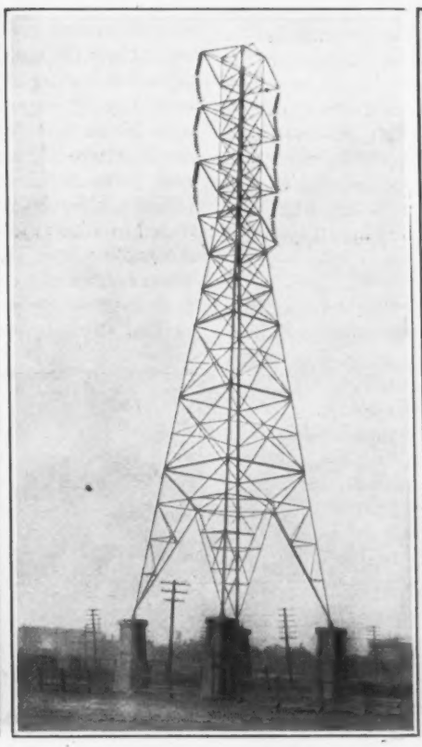


Fig. 7—Small Angle Tower.

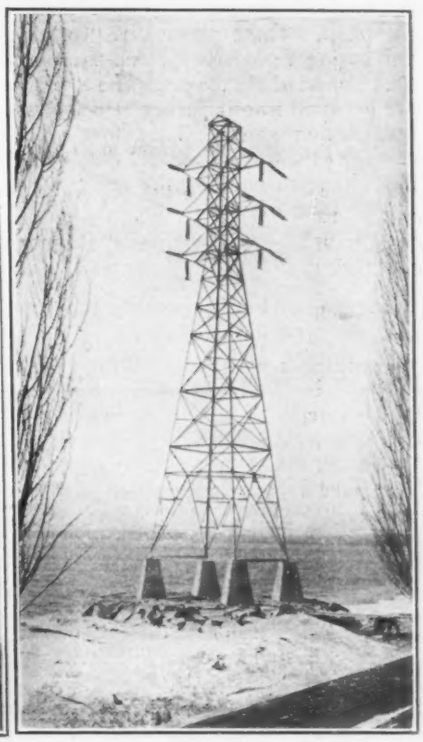


Fig. 8—Toronto Entrance Tower.

SURVEYS.

The territory embraced by the high-tension system was first covered by reconnaissance to determine the most feasible route. This preliminary examination was undertaken with the primary intention of adopting a route parallel to traveled roads wherever possible, in order to reduce the transportation, maintenance and patrol costs to a minimum. In selecting the route care was also taken to avoid any sections of country subject to electric storms. In fact, some projected and otherwise favorable routes were abandoned as a result of information obtained from telephone and

telegraph companies already located in those vicinities.

After the various routes had been selected an instrument survey was made. No profiles of the route were necessary, for the towers were located and staked in the field, and the locations thus established were plotted on

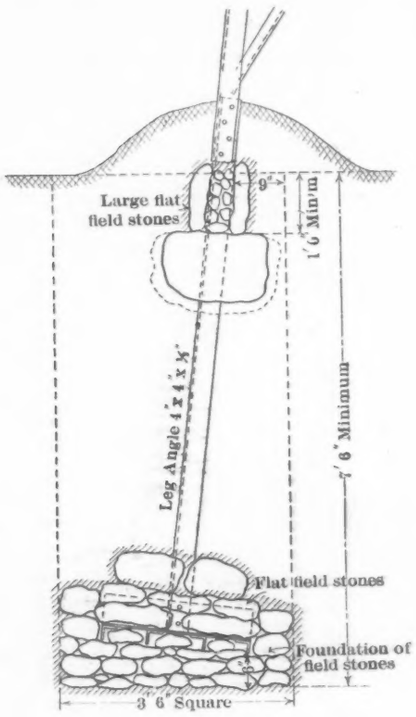


Fig. 9—Standard Footing Setting.

the plans. These plans were used by the commission in purchasing right-of-way, and later by the contractor for the location of the towers. The tower locations were staked out by small transit parties sent into the field ahead of the construction gangs. They first set a hub marking the center of the tower base and then two offset hubs along the tower tangent marking the center of opposite sides of the square base of the tower. A reference stake was also driven, upon which were marked the number, type and chainage of the tower.

RIGHT-OF-WAY.

The substation sites were purchased by the commission, and the transmission line right-of-way was acquired as easements, giving the commission the right for thirty years to enter upon property and to construct, maintain, operate, repair and patrol the transmission line. Every property owner along the route of the transmission line signed an agreement whereby, for an agreed amount mentioned therein, these rights and privileges were conferred upon the commission for thirty years. The remuneration included compensation for all trees, houses, barns or other obstructions which were removed permanently from the right-of-way. Patrol rights were only purchased on cross-country sections, not being needed where the line followed the highways. The patrol paths are 4 ft. wide and are provided with light steel gates at all intersecting fences.

The commission has the right to renew these contracts at the end of thirty years at the original price or at a price to be settled by mutual agreement or arbitration. This method of acquiring right-of-way dispensed with the necessity for fencing, and permits the land under the line and between the legs of the towers to be cultivated.

FOOTINGS.

The standard tower footings consist of riveted-steel grillages 28 in. square for each leg of tower, buried in the soil at a depth of about 7 ft. and bolted to an 8-ft. leg angle projecting 12 in. to 15 in. above the natural surface of the ground. Similar footings are used for long span and corner towers. The steel, however, is heavier, and the grillages are 42 in. square.

The grillages were shop-riveted and the leg angles bolted to them in the field. The footing steel was not galvanized, receiving instead two coats of special protective paint. Approximately 1000 tons of footing steel were required for the contract.

The four footing pits required for each tower were blocked out by two men with a light wooden templet from the three hubs previously set. A gang of laborers followed to excavate the pits to a minimum depth of 7 ft. 6 in.

Closely following this gang came one of twelve men and a foreman. They carried a steel templet, the corner posts of which had the same slope as the leg angles of the towers. This gang dropped the footings into the pits, bolted the leg angles of the footings securely to the corner posts of the templet (Fig. 10), lined it up with the three hubs set by the locating party, leveled it on four sides with a spirit-level, placed the field stones, back-filled the pits and thoroughly tamped them with iron tamping bars, as shown in Fig. 9. This gang also carried water to wet the backfill as it was replaced. An average day's work for this gang under favorable conditions was five sets of footings a day. The labor cost on standard tower footings in moist or dry soil was from $15 to $25 a set. This included the cost of excavation, setting and back-filling.

In places where quicksand, rock or very wet soil was encountered special construction was necessary and another gang was employed for this purpose. In swamp, where good bottom was within reach, the pits were shored and the soft material was removed. The shoring was left in place and the pits refilled to the proper depth with good material. The footing was then set in the usual way. In permanently wet clay or clay loam auxiliary grillages were placed above and below the ordinary steel grillages to distribute bearing pressure further and increase the upheaval resistance. This auxiliary grillage consisted of two cross-laid layers of 4-in. plank 5 ft. long spiked together below and four 3-in. planks cross-laid and spiked above the steel grillage. Where rock was met less than 6 ft. from the surface a fox-tailed anchor bolt with pier construction was used (illustrated in Fig. 11). Connections between the lower legs and the anchor bolts were made by means of heavy steel shoes. Where corner towers were placed on long spans, large angles or in poor locations the concrete footings shown in Fig. 12 were used. The cost of this footing, including

Fig. 10—Footing Being Set, Showing Templet.

material and labor on excavation and forms, was from $50 to $190, the higher cost occurring in isolated locations not easily accessible. The standard steel grillage and leg angles weighed 690 lb. per tower, while special heavy footings weighed 1830 lb.

TOWERS.

The towers are constructed of open-hearth medium steel and were built from designs prepared by the engineers of the Hydro-Electric Power Commission in competition with designs submitted by the contractor. Sample towers were built from both designs, and exhaustive tests at the shops of the tower manufacturers proved that the tower built from the commission's design was the stronger tower of the two. This tower withstood, without appreciable injury, a horizontal stress of 20,000 lb. at the center of the lower cross-arm, and finally failed at 20,950 lb.

The average cable span length on tangents for level country is 550 ft. This is varied elsewhere to suit topographical conditions. Approach spans to angles in the center line vary from 400 ft. on angles up to 8 deg. to 100 ft. on angles of 45 deg., the maximum angle turned on one tower. The towers were delivered "knocked down" in bundles to various railway sidings and transported by team to the line. All connections were made by means of galvanized bolts, the required number being delivered with each tower.

An assembling gang, usually consisting of eighteen men including a foreman and sub-foreman, followed over the ground previously covered by the footing gang. Two men from this assembling gang went ahead to break out the bundles and lay out the towers on the ground. The main gang assembled the body of the tower. The cross-arms were assembled by a gang of three men and a sub-foreman following the latter. All bolts were drawn up tight and the projecting threads burred with a hammer or center-punch. This assembling gang working winter and summer could assemble an average of about three and one-half towers a working day. Under favorable summer conditions from five to six towers a day were assembled. The average winter and summer labor cost for assembling a double-circuit tower was $10; the maximum cost in winter with heavy snow was $24, and in summer with good weather conditions $6.25 a tower. The single-circuit towers were assembled in summer at an average cost of $7.35 a tower.

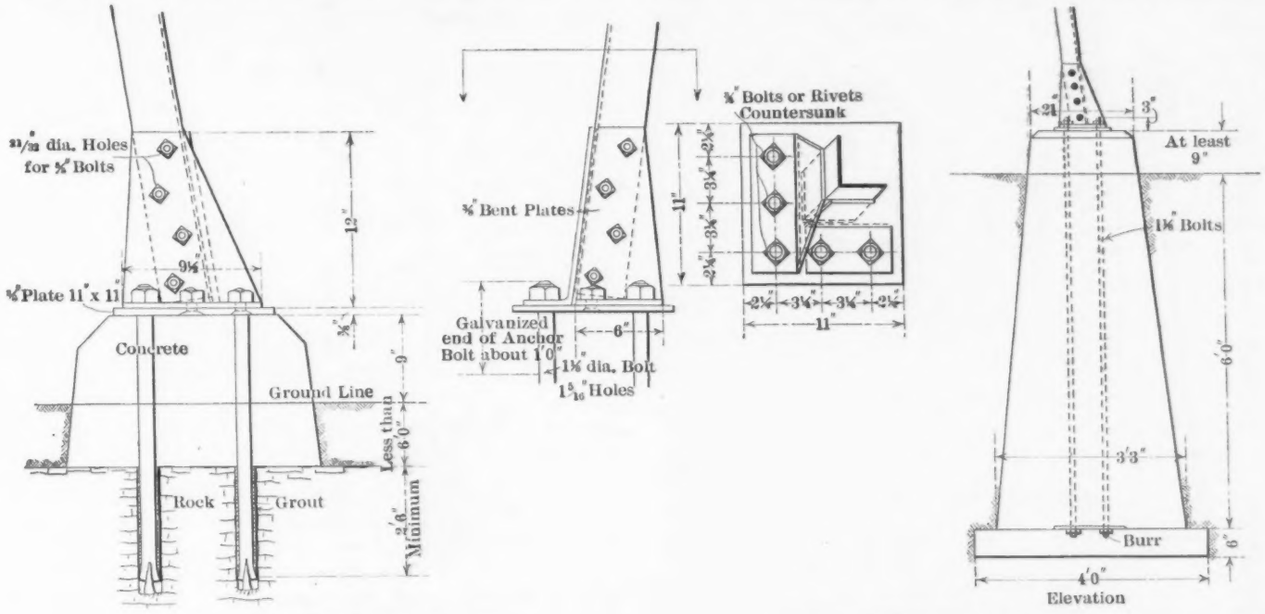


Fig. 11—Rock Footing and Details.

Fig. 12—High Tower Footing.

The erection gang, consisting of five or six men with a foreman and team, followed the assembling gang. Gin-poles, A-frames and shear-legs were variously employed to erect the towers, the shear-leg method being found the most satisfactory. The method of erection was as follows: Temporary stiffening struts were bolted to the tower legs; then the shear-legs were placed in a vertical position about the center of the tower base and the toes securely snubbed; a heavy line leading from a set of double blocks was then carried over the shear-legs and attached to the tower just below the lower arm; the blocks were snubbed to "dead-men" and the tower drawn into a vertical position by a team, after which stiffening struts were removed and the tower legs bolted to the footing angles. The average rate of erection under various conditions was about four towers a working day. During the summer and in good country eight towers a day could be erected in straight runs by the erection gang. The average labor cost for erecting double-circuit towers was $4.75 a tower, the minimum cost $2.45. Single-circuit towers were erected at an

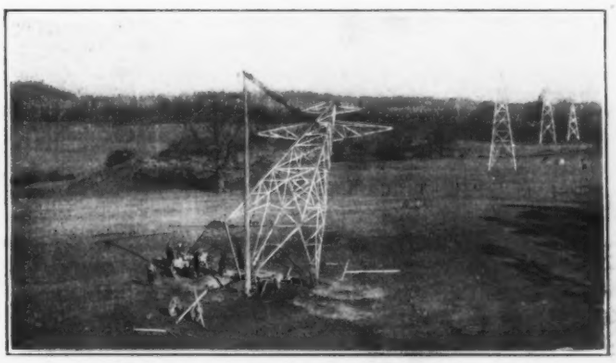


Fig. 13—Erecting Tower with Gin Pole.

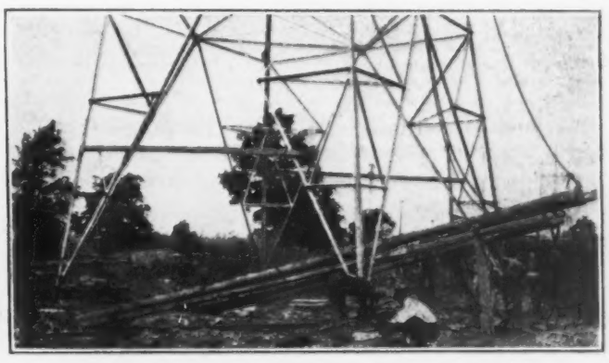


Fig. 14—Erecting Tower with Shear Legs.

average cost of $3.50 a tower. All work on single-circuit towers was done in the summer and early autumn.

The double-circuit towers, of the general design shown in Fig. 3, are classified as "standard towers," "line anchor towers," and "corner and long-span towers." General specifications are given in Table II.

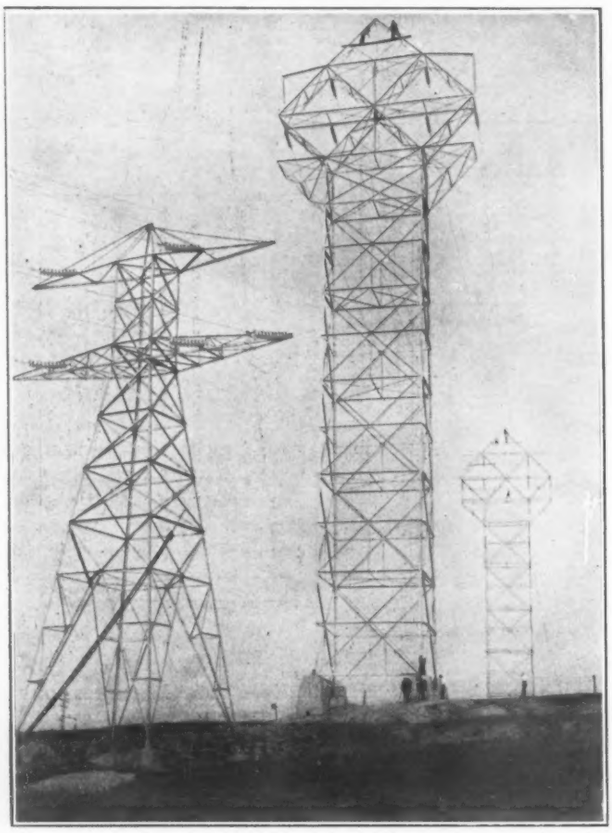


Fig. 15—Special Towers, Welland Canal Crossing.

TABLE II.—SPECIFICATIONS FOR DOUBLE-CIRCUIT TOWERS.

	Standard Towers.	Line Anchor Towers.	Corner and Long-Span Towers.
Averaged assembled weight, galvanized, without footing	3995 lb.	4560 lb.	5020 lb.
Total over-all height	65 ft. 6 in.	61 ft. 4 in.	61 ft. 4 in.
Total spread of upper arm	16 ft. 10 in.	17 ft. 6 in.	17 ft. 6 in.
Total spread of lower arm	35 ft. 2 in.	39 ft. 6 in.	39 ft. 6 in.
Dimensions of base	17 ft. sq.	18 ft. sq.	18 ft. sq.
Height of lower cable suspension from ground	45 ft.	45 ft.	45 ft.
Spacing of insulator connections	9 ft.	10 ft.	10 ft.
Minimum distance of cable from tower leg; maximum swing	3 ft. 6 in.	5 ft. 10 in.	5 ft. 10 in.
Total number of towers required	2295	105	176

The single-circuit towers, of the general design shown in Fig. 4, are classified as "standard towers" and "anchor towers." General specifications are given in Table III.

TABLE III.—SPECIFICATIONS FOR SINGLE-CIRCUIT TOWERS.

	Standard Towers.	Anchor Towers.
Average assembled weight, galvanized, without footing	3200 lb.	3450 lb.
Total over-all height	64 ft. 6 in.	67 ft.
Total spread of arms	18 ft. 3 in.	18 ft. 3 in.
Dimensions of base	16 ft. sq.	16 ft. sq.
Height of lower cable suspension from ground	45 ft.	50 ft.
Minimum distance of cable from tower leg	6 ft.	6 ft.
Total number of towers required	335	62

In addition to the above-mentioned standard towers, the following special towers were required: Twenty-eight double-circuit towers designed to support the lower conductors 50 ft., 55 ft. and 70 ft. above ground, employed for crossing high-tension transmission lines; forty double-circuit towers (Fig. 8) designed to give 70-ft. conductor clearance above ground, employed within the corporate limits of Toronto; two double-circuit towers giving 150-ft. navigable clearance over the Welland Canal, and thirty-six horn-gap towers 19 ft. in height at station entrances.

The towers used in crossing the Welland Canal (Fig. 15) weighed 25 tons each and were erected on specially designed reinforced-concrete footings. The complete system required in all 3040 towers, and the total weight of galvanized material ordered was 6200 tons.

Subsequent articles will describe the insulators and insulator tests, the aluminum cable and its erection, substations and interswitching stations, low-tension lines, etc.

THE COMPARATIVE VALUES OF WATER-POWER AND STEAM POWER.

Advantages and Disadvantages of Hydroelectric Stations for Central-Station Service Compared with Steam-Driven Stations—Financial Considerations Involved.

By A. C. Dunham.

THE utilization of the water-powers of the country has become a question of considerable importance to the public. Their value has been greatly confused by misstatements made by promoters, some of them made unintentionally and others made carelessly and perhaps purposely.

The writer has thought it best to try to analyze the question of water-power, considering the various and many conditions under which it has been and can be developed, and to give some idea of what constitutes its value and what are its advantages and disadvantages compared with steam.

The question divides itself naturally into different heads which have to be analyzed and discussed separately. In the first place, although water-power was of much greater value relatively than steam from fifteen to twenty years ago, the cost of steam has greatly declined since then, but water-power still remains at about the ame level. The public has lost sight of this fact owing to ignorance of the immense advance made in the art of steam generation and utilization. Another point which is steadily overlooked is the fact that the value of a hydroelectric station does not depend upon its average output, but under most circumstances, especially if it is a new development and not already connected with a steam station, the minimum is the only output to be considered for valuation purposes. Unfortunately valuations are generally based on the average output taken in connection with the maximum power available. Of course, it would be very difficult to determine the relative values of water-power and steam-power under all possible conditions, but in general the price of coal is the determining factor.

Forming part of this article are facts elicited in the legal test between the city of Worcester, Mass., and the owners of certain mills situated on the Blackstone River. In this suit the relative value of steam-power alone and steam-power used in connection with six water-powers was determined by very careful engineering analysis.

The accompanying tables are based on values given by Mr. A. F. Nagle, in his "Analysis of the Commercial Value of Water-Power."[1]

Table V, giving the cost of power at Tariffville, Conn., as developed by the Hartford Electric Light Company from

[1] *Trans.* A.S.M.E., Vol. XXIV., page 286, 1903.

1901 to 1910, clearly shows that if the water-power were continuous it would possess a value several times greater than when connected with a steam station, yet owing to the fact that it steadily varies its value is considerably lessened.

The Farmington River has a reservoir at Otis which is supposed to store sufficient water to supply the entire power needs of the river for two months. It was originally supposed to contain enough water for this purpose for three months, but owing to the decline in the amount of rainfall and storage a two months' supply is all that can be counted on, so that it will compare very favorably with most rivers of this class. However, the figures show that its value for power purposes cannot be safely inventoried or safely carried on the books of any company at more than one-third that given it by some engineering concerns.

Consideration has also been given the water-power supplied at Schaghticoke, N. Y., as another illustration of the peculiarities in the value of hydroelectric properties.

TABLE I.—ESTIMATED ANNUAL COST* OF STEAM-POWER PER INDICATED HP. SIMPLE CONDENSING ENGINES.

Horse-power =	50.	75.	100.	150.	200.	250.	300.	400.	500.
Cost of plant per hp.	$90.00	$75.00	$65.00	$57.00	$51.00	$47.00	$45.00	$43.00	$42.00
Cost of banking (no heating), repairs, supplies, engineer, etc., per hp.	9.00	8.50	8.20	8.30	8.60	8.30	7.90	7.85	7.80
Annual (3060 hours) cost of coal at $4.50 per long ton per hp.	25.00	22.00	20.00	17.00	15.30	15.00	14.60	13.85	13.00
Total annual cost per hp.	34.00	30.50	27.20	25.30	23.90	23.30	22.50	21.70	20.80

*These prices do not include interest on plant or cost of deterioration.

TABLE II.—ESTIMATED ANNUAL COST * OF STEAM-POWER PER INDICATED HP. COMPOUND CONDENSING ENGINES.

Horse-power =	400.	500.	600.	700.	800.	900.	1000.	1200.	1500.
Cost of plant per hp.	$64.00	$60.00	$57.50	$56.00	$55.50	$55.00	$54.60	$54.00	$53.00
Cost of banking (no heating), repairs, supplies, engineer, etc., per hp.	7.30	7.60	7.75	7.80	7.95	7.70	7.55	7.50	7.50
Annual (3060 hours) cost of coal at $4.50 per long ton per hp.	12.30	11.40	10.50	9.85	9.50	9.30	9.25	9.25	9.20
Total annual cost per hp.	19.60	19.00	18.25	17.85	17.45	17.00	16.80	16.75	16.70

*These prices do not include interest on plant or cost of deterioration.

Consideration has also been given the water-power supplied at Schaghticoke, N. Y., as another illustration of the peculiarities in the value of hydroelectric properties.

TABLE III.—VALUE OF WATER-POWER AT DIFFERENT MILLS.

Mill Number.	Required Mill-Power in Horse-Power.	Average Water-Power in Horse-Power.	Average Steam-Power in Horse-Power.	Maximum Engine-Power in Horse-Power.	Value Full Water-Power.	Value Part Water-Power
1	900	690	210	370	$17.00	$13.70
3	1750	720	1030	1260	16.70	14.27
4	1000	444	556	700	16.80	11.82
5	1100	860	240	500	16.80	12.77
9	280	115	165	210	22.80	16.25
14	1300	550	750	1200	16.70	10.09
..	....	..	....	....	*47.80	*28.85

*Electric-power station, calculated upon 365 twenty-four-hour days a year. All others upon 306 ten-hour days.

The Farmington River at Tariffville has a fall of 32 ft. and ranks among the lesser water-powers used in transmission plants. At the Schaghticoke plant there is a drop of 150 ft., and the results obtained for the year 1909, which was a very poor year for water-power all through the eastern United States, show that without steam reserve or insurance the Schaghticoke station would have been worthless for a large part of the time.

On the Housatonic River there is a fall of 110 ft., which is quite sufficient to determine the value of water-power under very good circumstances. The station on that river has six generators of 1000 kw each, which are so rated that they can carry 7000 kw if all are put in use at one time. The fact that they are installed shows that there was an expectation of using them at some time when the water supply was abundant. Now the waterwheels which drive these six generators have been reconstructed to give the generators their maximum rating, and the output per annum, if the machines were run twenty hours a day, would be 51,100,000 kw-hours.

In the year ended June 30, 1911, the actual output of this plant was 20,980,000 kw-hours, or about 40 per cent of the maximum, while the minimum output for any one month, that of October, 1910, was 640,000 kw-hours, the maximum output for any one month being 2,640,000 kw-hours. As the energy is largely used by trolley roads, obviously the station must be able to supply electricity through twenty hours of each day; but part of the energy is also used in factories running ten hours a day, and in

TABLE IV.—METHOD OF COMPUTING VALUES OF PARTIAL WATER-POWER.

Required mill-power, hp.		900
Average water-power, hp.		690
Average steam-power, hp.		210
Maximum steam-power, hp.		370
Time engine runs, months.		12
Full annual cost 900 hp, compound condensing plant, at $17.00.		$15,300.00
Annual supplies, etc., 370 hp, simple condensing plant, at $7.85.	$2904.00	
Annual coal, 210 hp, simple condensing plant, at $14.00.	2940.00	
Total cost 210 hp, steam.	$5844.00	5,844.00
Cost 1 hp steam.	27.80	
Value 690 hp water		$9,456.00
Value 1 hp water.		13.70

lighting substations, operating perhaps on the average four hours a day, and it becomes clear that a steam reserve had to be supplied as rapidly as possible to make up the deficiencies of dry seasons. In one year this company paid $80,000 for auxiliary steam-power to augment its

TABLE V.—COST OF INCONSTANT INSURED WATER-POWER, TARIFFVILLE STATION NO 2, 1901-1910.

Minimum output—November, 1908—kw-hours	98,050
Required plant equipment (twenty-six twenty-hour days), kilowatts	188.5
Maximum output—November, 1907—kw-hours	899,285
Plant equipment, kilowatts	1729.4
Insurance (auxiliary steam plant equipment) required (1729.4 − 188.5 kw)	1540.9
Operation and maintenance costs:	
Water (average 1901–1910) per kw-hour	$0.001254
Steam (average 1905–1910) per kw-hour	0.007558
Insurance cost:	
1540.9 kw, at $110	$169,700
Required earnings (15 per cent)	25.420
Yearly output (1908), kw-hours	5,270,250
Insurance cost per kw-hour	$0.004830
Total cost:	
Operation and maintenance per kw-hour	$0.001254
Insurance cost per kw-hour	0.004830
Total cost per kw-hour	$0.006084

water-power, the electrical-energy-generated steam being sold to it at a very low rate.

The deductions which can be made from these four typical water-powers and the conclusions which can be

TABLE VI.—OPERATING AND MAINTENANCE ACCOUNTS.

	Steam, Dutch Point Plant. Per Kw-hour.	Water, Tariffville Station No. 2. Per Kw-hour.
1901	.....	$0.00130
1902	.....	0.00082
1903	.....	0.00110
1904	.....	0.00106
1905	$0.00950	0.00093
1906	$0.00716	0.00111
1907	0.00798	0.00126
1908	0.00779	0.00236
1909	0.00640	0.00140
1910	0.00650	0.00120
Average	0.007558	0.001254

drawn are very easily formed. The mills on the Blackstone River were the subject of a damage suit, and the gross sum awarded was very large; but in the majority of cases the water-power formed only a very small part of the issue

TABLE VII.—COST OF INCONSTANT INSURED WATER-POWER, SCHAGHTICOKE, 1909.

Minimum monthly output, kw-hours	456,000
Required plant equipment (twenty-six twenty-hour days), kilowatts	876.25
Plant equipment, kilowatts	15,600
Insurance required (15,600 − 876.25 kw)	14,723.75
Operation and maintenance costs:	
Water (estimated) per kw-hour	$0.001481
Steam (estimated) per kw-hour	0.007558
Insurance cost:	
14,723.75 kw, at $72.00	$1,060,000
Required earnings (15 per cent)	159,200
Yearly output, kw-hours	50,000,000
Insurance cost per kw-hour	$0.003185
Total cost:	
Operation and maintenance per kw-hour	$0.001481
Insurance cost per kw-hour	0.003185
Total cost per kw-hour	$0.004666

in dispute. However, these figures are useful as showing the relative value of water-power and steam-power in a district where the price of coal is very uniform and where the quantities of steam-power and water-power used together varied considerably and gave a unit of value which could quite easily be used. This is the reason the writer has given in this paper a method for considering the value of water-power versus steam-power which takes cog-

TABLE VII.—COST OF INCONSTANT INSURED WATER-POWER, HOUSATONIC POWER COMPANY, YEAR ENDED JUNE 30, 1911.

Minimum output, October, 1910, kw-hours	640,000
Required plant equipment (thirty twenty-four-hour days), kilowatts	1066.6
Plant equipment, kilowatts	7000
Insurance required (7000 − 1066.6 kw)	5933.4
Operation and maintenance costs:	
Water (estimated), per kw-hour	$0.001481
Steam (estimated), per kw-hour	0.007558
Insurance cost:	
5933.4 kw at $90	$534,006.00
Required earnings (15 per cent)	80,200.00
Yearly output, kw-hours	20,980,000
Insurance cost per kw-hour	$0.003820
Total cost:	
Operating and maintenance per kw-hour (estimated)	$0.001481
Insurance cost per kw-hour	0.003820
Total cost per kw-hour	$0.005301

nizance of the cost of steam and the quantity of water-power used with it at any given time.

The company at Schaghticoke is owned by the General Electric Company. The development was made at a point on the Hoosac River a few miles north of Troy, which was supposed to yield a very constant flow. The engineers installed four 3000-kw generators on a fall of 150 ft. and two 1800-kw units on a fall of 32 ft. at a point above the larger installation.

The energy is used by a large district of trolley roads, and also by the General Electric Company at Schenectady, so that by the two installations an illustration of a double use of the water-power is furnished and a very favorable comparative value secured.

The development was made on the basis of an output of 50,000,000 kw-hours per annum, this being the estimate of the General Electric Company's experts, on the assumption that 50 per cent of the nominal available power would be obtained. In the year 1910 the actual output was 35,000,000 kw-hours, the minimum output for any one month being 456,000 kw-hours.

This station operates under the same conditions as to hours as that on the Housatonic River, and requires a constant flow for twenty hours a day, it being owned and operated by the General Electric Company, which has a large steam station at Schenectady and which furnishes steam-power when the water-power ceases to be operative, making the latter really a by-product.

It appears from Table V that the rating of the equipment installed at Tariffville is about 1600 kw. The experience of the Hartford Electric Light Company in the use of this equipment shows that only about one-half of it was used during ten years. In other words, this development, instead of yielding steadily 1600 kw, gave on the average 800 kw. Now the value of the development is still further impaired, from the fact that during ten years the minimum output for some one month, as, for example, November, 1908, was 98,050 kw-hours, as against a maximum of 899,285 kw-hours in November, 1907. The difference between this maximum and minimum must be provided for by steam insurance in case the hydroelectric station is useful for an output of an average of, say, one-half of the rated capacity of its equipment.

The figures are not theoretical, but are absolutely the result of experience as recorded every day for nine years, and give an excellent example of the great difficulty of estimating the value of the most stable water-powers, with the exception of two or three east of the Rocky Mountains.

In comparing the value of hydroelectric stations there has been taken into account not only their cost of installa-

tion as compared with steam, but also the fact that, through modern inventions, the difference in labor cost between the two systems has been almost obliterated.

It may be said that reserve steam stations could be placed at favorable points, but they also could be placed at these points if there were no hydroelectric developments, and their cost would be about one-third of the cost of the hydroelectric and the steam stations combined, and, of course, steam stations would only have to earn about one-third of the profit necessary for the two plants combined.

In addition to these computations there is the necessity in the case of a hydroelectric station, and not in the case of steam, that a market has oftentimes to be created, and this is, of necessity, a slow process, as is evidenced by the experience of the Niagara Falls Power Company. This magnificent development has existed many years and has just begun to pay expenses, having meantime lost, through interest and maintenance, the original capital invested.

Many of the best engineers in the art of developing electric energy and applying it to useful purposes have arrived at the conclusion that, on the whole, in any new installation steam-power can be employed with much greater chances of profit than almost any water-power in any part of the United States, except where coal is very high in cost. Under the most favorable conditions steam-power now costs one-fourth of what it did fifteen years ago, and under any conditions not more than one-third what it did at that time.

FIELD-CONTROL PROBLEMS IN DIRECT-CURRENT MACHINES.

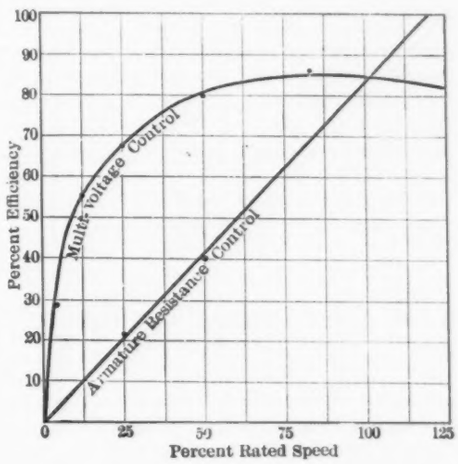
By William G. Merowitz.

SPEED regulation of direct-current motors, from an economical point of view, is an important factor in electrical engineering practice of to-day. Accordingly, motor manufacturers have designed and proportioned their lines of variable-speed direct-current motors, to give the best results, with that point in mind, by the method of field control for speed variation. The other two methods in general use at present for varying the speed of direct-current motors are the multi-voltage system and the armature rheostat control. The former method has a slight tendency to complication, due to the extra balancers, wiring and controllers needed for its operation, although the efficiency of the system is high and its steadiness is assured. The great disadvantage of the armature rheostatic control lies in its inefficiency over the range of speed variation and in its unsteadiness under load changes. A comparison of the efficiencies of the multi-voltage system and the armature rheostat method of speed control is shown in the accompanying curves, which were plotted from rated torque data.

There is little difference in the sizes of frames used for a constant horse-power over a certain range of speed in both the multi-voltage and the armature-resistance control methods; the normal rating of the machine decreases in each case proportionally to the drop of speed. The aim of field control must be to wind this same frame for the normal low-speed output corresponding to the low speed, and endeavor to maintain this output over the whole range of speed with at least satisfactory, if not perfect, commutation at the maximum speed. The increased permissible output at high speeds of the motors controlled by the multi-voltage or armature-resistance methods can in most cases be considered only the overload range at that particular speed and is not of as great value as one might conclude offhand. Especially for machine-tool drive, there is a general tendency to a greater output at the lower speeds; for example, a heavy cut on a large-diameter steel shaft, as against a finishing cut on a piece of small diameter at high speed.

The method of introducing resistance into the field circuit of a direct-current motor, thus decreasing the field flux and causing the armature to run faster, in order to generate its counter emf, is a well-known method for controlling the speed of motors. The method is undoubtedly simple, requiring only one voltage, and the motor delivers its power at a high efficiency throughout the entire range of speed. Direct-current motors are usually designed for such high-flux density in the field cores that it is not practicable to increase the flux materially, and therefore the field is weakened for speed control. Such adjustable-speed machines are not constant-torque motors, but have a constant horse-power output; that is, the torque decreases as the speed increases in the inverse ratio.

The general objection to field control by the operating and designing engineer results from the apparent impossibility of obtaining uniform and good commutation at the brushes. The ordinary shunt motor when loaded to normal output at a higher than normal speed, obtained by weakening the field, shows a tendency to spark. Of the various points that come up for consideration in improving the commutation, three are of main importance: (1) The limiting ratio between the ampere-turns expended for air-gap and teeth, against the armature ampere-turns under



Comparative Efficiencies of Multi-Voltage and Armature Resistance Control.

a pole; (2) the self and mutual inductance of the armature-winding section undergoing commutation at the brushes, and (3) the self-inductance of an armature section at the point of leaving the brushes. Regarding the ratio of ampere-turns, reversible motors are frequently built to specifications requiring absolutely no sparking, with a fixed brush position from no-load to full-load. These motors are only slightly dependent upon what might be called magnetic commutation, and they could, no doubt, be used satisfactorily as non-reversible motors, with considerable weakening of the field flux. Actual tests have shown that, even with a normally high density in the teeth, reducing the pole shoes to a smaller arc increases the reluctance of the magnetic circuit to only a small degree. The advantage of decreasing the cross-magnetization, by reducing the pole shoes to a smaller arc, is apparent from the fact that the armature current has less chance to magnetize the one side and demagnetize the other side of each field pole, thus causing the distorting effect known as cross-magnetization. To produce a satisfactory ratio of ampere-turns expended for air-gap and teeth to armature ampere-turns under a pole, allowance must be made for a slight increase in temperature rise, for an additional amount of copper in the field coils and for increased ventilation of these coils. With such additions a satisfactory ratio may be obtained, even with a considerably weaker field than usual. When, now, a point of high speed is reached where this ratio,

owing to weaker field, becomes too low, it is necessary to reduce the other two components of sparkless commutation mentioned above, namely, the self and mutual inductance, which can be accomplished by making the armature length as small as possible, having a low ratio of depth to width of slot and using an open-slot armature.

There remains now one very important item affecting the inductance of the windings, namely, an increased number of commutator bars for the standard size frames, thereby cutting down the armature turns per bar. The number of turns per segment is of much importance, as the square of its value is used in computing the amount of self-inductance. The mechanical objection to increasing the number of commutator divisions is the difficulty of connecting the armature wires to the segments; this has been carried so far that a good solid connection for medium-size wires is obtained even with a bar not more than 30 per cent wider at the point of embedding than the diameter of wire. A safeguard against too high an inductance is a series winding on the armature, with as many ranges of brushes as there are poles.

The synopsis of the whole method is to keep the sum of the factors contributing to sparking down to a certain limit even when one of the factors goes above a value that has been found to be the limit. As an example, a 10-hp core normally operated at 1250 r.p.m. was wound to give a range of speeds from 250 to 1250 by means of field control, and at the maximum speed gave 3-hp output without a sign of sparking, all points mentioned above having been applied to this machine.

Test floor experience has proved that the shunt-field current of an interpole motor can be weakened and finally be decreased to zero without any tendency to run away; the interpole flux acts as the field, in that case.

LESSONS OF SOME RECENT GENERATOR AND MOTOR TROUBLES.

IT is safe to say that more can be learned from troubles occurring with apparatus in service than from successes, whether these be due to faults in design or operation. Few breakdowns of a sensational character occur in these days with motors and generators of first-class manufacture when the machines are selected and maintained with due regard to the service expected from them, but an examination of the records of a large British electrical accident insurance company for the past year shows that there is still room for improvement in the design and handling of such equipment. The essentials of a few typical cases are given below from the report of the chief engineer of this company, Mr. R. S. Longbridge.

The problem of lubrication was evident in the breakdown of a 130-hp induction motor operating at 485 r.p.m., the frequency being 50 cycles and the potential of the supply circuit 500 volts between each of the three phases. The rotor shaft was carried in bearings lined with white metal, and on account of a neglect in lubrication the metal in one bearing melted and ran out, letting the end of the shaft down upon the cast-iron shell. The drop was sufficient to bring the rotor into contact with the lower part of the stator, with the result that the projections between the slots were abraded and their edges pressed through the insulation of the conductors, eleven of the later being short-circuited. The accident indicated the doubtful wisdom of using white metal in self-lubricating bearings, which are seldom inspected. It also appeared desirable to provide for holes in the end plates permitting the measurement of the clearance between the rotor and the stator.

Excessive oiling caused another failure in which a small generator refused to deliver over 90 per cent of the rated voltage after having been several hours in use. The voltage was found to be normal on starting the machine, but fell off, with accompanying heated field coils, after service had been given. An inspection of the field coils, which had to be taken off and sent to a shop, showed that the windings were saturated with oil. All the wire of one coil was removed, cleaned in alcohol and re-wound. The other coil was in such bad condition that it could not be re-wound with the same wire, the insulation being charred and crumbled by the excessive heat. The bearings were supplied from sight-feed lubricators with adjustable feed, and the attendant's zeal in flooding them with oil resulted in the injury to the windings.

Improper arrangement of shunt-coil terminals caused a wire failure of suggestive interest. The machine was a two-pole generator, giving 55 amp at 220 volts when running at a speed of 750 r.p.m. The field coils were wound on rectangular forms with gun-metal flanges, and their terminals were carried on a block attached to the horn of one of the magnets. The inside ends of the shunt coils were led from the back to these terminals through fiber bushings in holes in the top flanges of the forms, the lengths of wire between the bushings and the terminals being unprotected and liable to be caught by waste or cloth used in wiping the machine. In this way one of the wires was broken inside the bushing, and the coil in connection with it had to be re-wound. The trouble indicated the importance of properly protecting shunt-coil leads from mechanical injury, and the inspection led to an emphasis in the report of the damage entailed in the case of a motor of about 66-hp rating whose shunt field was ruptured when the motor was running without load. The speed of the armature increased until the binding band at the pulley end burst and the conductors spread, damaging themselves, the core plates and the magnet coils so badly that the whole machine had to be re-wound.

Severe sparking at the commutator was cured in the case of a 5-hp motor by the process of undercutting the commutator so that the mica insulation was maintained at a level slightly below that of the copper bars. The sparking appeared to be due to the unequal wear of the copper and the mica, beginning at the trailing edges of the brushes and gradually increasing in severity so that the surface became roughened enough to require re-turning.

In another case a three-phase, 10-hp motor, with wound rotor and slip rings running at 720 r.p.m. and supplied with current at about 200 volts, short-circuited to the frame at the end of the shaft through which the wires were run to the moving element. The rotor shaft was hollow, and the taps from the three windings were led through it to the slip-rings, entering at three radial holes and emerging at the end at the bore of the shaft. The holes were not fitted with insulating bushings, and the cables were not attached rigidly. The insulation at the bends where they entered the shaft was worn through by the edges of the holes, one cable being fused and the insulation of the others nearly cut through. All three leads had to be replaced, and in properly bushed holes. In a similar motor of 30-hp rating the emerging ends of the taps were sweated upon copper strips which were led up to and bolted against lugs on the slip-rings, but no staying or fastening was provided except at these lugs. There was, therefore, relative motion between the slip-rings and the cable within the shaft, causing vibration and ultimately a fracture of the copper strips at bends close to their junctions with the slip-rings. The remedy was to pin the ends of the cables by a wood plug driven into the end of the shaft.

In a four-pole direct-current motor of 85-hp rating, running at 350 r.p.m. on a 480-volt circuit, three-wire type, with grounded neutral, several of the armature coils were short-circuited to each other and to ground. The armature was form-wound, the ends of the coils projecting beyond the slots at the commutator end being bound down upon a cast-iron drum with mica cloth insulation between them

and the metal. The motor frame was grounded. The causes of the short-circuit were destruction of the cotton covering of the conductors by friction between them and the edge of the cast-iron drum, owing to slight relative movements between the commutator, the conductors and the drum and the absence of proper insulating material at and over the edge of the drum. There was also a quantity of copper and carbon dust between the coils and the drum. The commutator was taken off; the burned coils were replaced and re-insulated, and the motor put back in service with ample insulation between the coils and the end of the drum. A similar case was that of a motor in which the troughs carrying the conductors in the armature slots were cut exactly to the lengths of the latter, instead of being permitted to extend over the edges to a small extent. The sharp bending of the conductors over the edges of the slots led to worn insulation and the failure of some of the coils. Had the insulating troughs been a little longer than the slots, so as to project slightly beyond the iron at each end of the armature, the weakness which causes many breakdowns similar to the foregoing would have been avoided.

The absence of a suitable terminal block on a motor frame led to a representative failure. The main and shunt leads of the motor were brought from the starting box and switch in steel conduit to within 3 ft. of the motor, and thence by a flexible tubing to a gland in the motor casing. Inside the frame they were connected with the brush and shunt leads by dry joints taped over, the joints lying on the bottom of the casing. In time these joints became loose and developed sufficient resistance to cause severe heating. The tape became ignited, and through it the rubber covering of the leads and the insulation of the magnet coils nearest the bottom of the frame were set afire. The burning leads short-circuited through the frame, but the fuse blew and the armature escaped without damage other than a slight scorching. The magnets were re-wound, and the new main leads from the starting switches were clamped directly upon the brush spindles with sufficient slack to allow for adjustment of the latter. The report of the accident pointed out that dry joints are often sources of trouble, and yet they are used on semi-inclosed and inclosed motors on account of the difficulty of making soldered joints inside the frame, and to avoid the trouble of making and breaking soldered joints when testing. All machines should have proper terminal boxes fixed upon the frames in which the leads from the windings can be connected electrically and mechanically to those from the main circuit.

A typical mechanical defect was illustrated in the case of a 4-hp motor making 1150 r.p.m. The armature core plates were threaded upon the shaft and compressed between two end plates which were secured between a collar at one end of the shaft and a split ring shrunk into a groove at the other end, the armature driving the shaft by a feather key sunk half in the shaft and half in the core. The commutator sleeve was held and driven in like manner. The inspector found the motor sparking badly at the brushes, and the commutator was so hot that about half the conductors were unsweated or loose. When the armature was taken out the core and commutator sleeve were both found to be loose on the shaft, and the driving keys and keyways were worn. The relative motion of the armature and commutator had broken the conductors above mentioned. The practice of depending on parallel feather keys, which are not made mechanical fits, for driving armatures, commutators and shafts is responsible for troubles of this kind.

A poor control arrangement was responsible for the frequent fuse blowing in the circuit of a 10-hp, four-pole shunt motor, operating on a 220-volt direct-current circuit. Skilled assistance was summoned on account of the frequent blowing of the fuse. The trouble occurred when the motor was being shut down, and was intermittent in character. There was no difficulty in starting or running. The inspector found that the motor drove a lathe with a 10-ft. face plate, for turning heavy castings; and that the starting switch, besides having the usual resistance in the armature circuit, was combined with a shunt resistance, as shown in the accompanying diagram, by means of which the speed of the motor and lathe could be increased about 15 per cent above the speed the supply voltage would maintain when the armature was running in the full field. With this information it became clear why the fuse sometimes blew when the current was being switched off, as follows: Suppose the lathe with a heavy casting bolted to the face plate to be running at 15 per cent above the normal speed with the lever of the starting switch in the position A3. It is clear that if the current were switched off the motor would continue to run above normal speed for a time depending upon the momentum of the casting in the lathe. Therefore, with castings above a certain weight, when the attendant moved back the lever to shut off the current, as soon as the position A2 was reached the motor would be running with its field fully excited and above its normal speed. It would therefore generate a voltage higher than the supply voltage and become a dynamo, attempting to carry all the load of the manufacturing plant. Had the attendant opened the main switch in stopping the motor the trouble would have been avoided. In the diagram it will be seen that when the handle of the starting switch was moved to the off position A1 the shunt was broken and the insulation strained by the high induced voltage. This is an additional reason why the shunt circuit should have been left closed until the current could collapse, after the opening of the main switch.

COAL PREMIUMS AND ECONOMIES IN A SMALL PLANT.

WHILE it is generally recognized that it is very desirable to enlist the interest of employees in economy of fuel and other supplies in the power plant, the payment of premiums or bonuses to employees for economical operation is by no means common. In some cases it is difficult to put in force such a premium system where a plant is supplying a number of different classes of service. In many cases, however, it is very simple.

The Menominee Range, Power & Development Company, of Iron River, Mich., which gives electric light and power service in Iron River, Stambaugh and surrounding iron-mining towns, operates a small steam plant consisting of two horizontal return-flue boilers of about 125-hp rating and two engines, one a Lane & Bodley simple Corliss of about 100 hp driving a 90-kw generator, and the other a tandem compound condensing Buckeye medium-speed engine direct-connected to a 175-kw generator. Much of the machinery is not in first-class condition, having been purchased second-hand with a view to furnishing power a few years until such time as hydroelectric power could be transmitted to the town. In view of the water-power possibilities, the company wisely thought best not to spend too much on a steam plant. Nevertheless, the high cost of fuel makes it desirable to get the best possible results out of the existing plant.

The plant was put under the general management of Mr. J. R. Cravath, of Chicago, with Mr. G. Clinton Smith as local superintendent, on April 1, 1911. Records had not been kept previously of the output in kilowatt-hours or of the coal consumption from day to day. Estimates on the probable output of the previous year seemed to indicate coal consumption of somewhere between 14 lb. and 18 lb. per kw-hour. Coal in the bin costs from $3.50 to $4 per ton. Output meters were put on the switchboard and an effort was at once made to reduce some of the more important losses. The plant was necessarily operating under

uneconomical conditions because of a very small day load. It is necessary to operate a 90-kw unit throughout all the light-load period. One change immediately made was to bank the fires in one boiler during the day instead of operating both boilers with slow fires during the twenty-four hours. Full steam pressure was left on the banked boiler. This practice was intended to do away with the furnace-heat radiation losses in maintaining two fires at working temperature.

Leaks of air through the boiler setting were stopped as far as possible, and later the entire boiler setting was covered with canvas and this canvas was filled full of paint to stop the flow of air through brickwork and cracks into the furnace. Special instructions were given the firemen as to firing evenly so as to allow as little excess air to get through holes in the fire as possible. The engines were indicated and the valves were reset with the aid of the indicator diagram. In the case of the 90-kw unit which operates during about eighteen hours per day on light load, a set of new valves was purchased in the belief that the coal economy for the next eighteen months would pay for the change. A flue-gas analysis apparatus for testing samples of flue gas was purchased of the Combustion Appliances Company, of Chicago, and the men began experimenting to learn what method of handling the fires gave the best percentages of carbon dioxide. It has been well established that an excess of air above that needed for combustion in a boiler furnace is one of the commonest sources of loss because of the heat which is wasted in heating up this excess air. While the analysis of samples of flue gases shows the firemen what method of handling fires gives the most economical results, this information is of no value unless made use of continually in the regular operation of the plant by the firemen. In order to secure the continued interest in coal economy of the men operating the plant a coal premium system was put in force on Aug. 1, 1911. An exact reprint of these rules as they are posted in the plant follows:

RULES FOR COAL PREMIUM.

"The company appreciates the interest taken in coal saving by its employees and wishes further to add to and reward this interest by the following plan for the payment of coal premiums:

"At the end of each month the amount and cost of coal per kw-hour for the month will be figured from the power-house report. The company estimates that the following figures are somewhat in excess of the cost of coal per kw-hour for the coming year, and they will be used as a basis for figuring coal premium: August, 2.2 cents per kw-hour; September, 2 cents; October, 1.9 cents; November, 1.8 cents; December, 1.7 cents; January, 1.8 cents; February, 1.9 cents; March, 2 cents; April, 2.1 cents; May, 2.2 cents; June, 2.3 cents; July, 2.3 cents.

"If the coal consumption is below the figures in the foregoing table, the money value of the saving so effected will be divided with employees as follows: Twenty-five per cent of the saving will be set aside as a coal-premium fund to be paid to employees. Of this 25 per cent one fifth will be held six months to enable the company to check the accuracy of the daily coal weighings with the coal purchased by railroad weight. The other four-fifths, or 20 per cent of the total saving, will be paid in cash each month to the two engineers and lineman. The division between these three men will be as follows: Night engineer, 40 per cent; day engineer, 40 per cent, and lineman, 20 per cent.

"Accidents caused by the gross carelessness of an employee who participates in the benefits of these coal premiums will wipe out the coal premium of such employee for the month unless the employee chooses to pay for the cost of such accident.

"In case it is found that the coal as weighed in the boiler-room each day does not check with railroad weight, the company will make every effort to determine the true cause of such discrepancy. If after investigation it appears that there has been an error in the boiler-room weight in favor of the employees, the 5 per cent reserve will be used to pay the company for the difference. If, on the other hand, boiler-room weights are higher than the weights by which the coal is purchased and if the investigation proves that the railroad weights are probably correct, the 5 per cent reserve will be paid to the employees and any additional premium that may be due because of error in the original boiler-room weights from which the premium was figured."

In drawing up these rules it was decided to base the payment of premiums on actual saving in cents per kw-hour for fuel rather than upon pounds of fuel, because a number of different kinds of coal are available. Under the rules as drawn up both company and employees are interested in using the coal which means the lowest cost per kw-hour regardless of the trouble of handling or firing some of the cheaper grades. The reason for including the lineman in the coal premium payments is that he spends part of his time at the plant and hence is partly responsible for the results attained. The results have been very satisfactory. Because so many changes for economy were made about the same time, and because the load is growing very rapidly, it is difficult to determine just how much saving has been due to any one of the improvements mentioned, but the results as a whole can be seen from the accompanying table. The output for the month of September was nearly one-third greater than in May, and the coal in September was about the same as for May. The high coal consumption during June was due partly to the light load and partly to the fact that the large unit had to be operated a number of days while repairs were going on with the small unit. The figures in this respect are a striking illustration of the importance of not having units very much too large for the load which they are intended to carry.

PLANT PERFORMANCE, IRON RIVER, MICH.

Month.	Total Pounds Coal.	Output.	Pounds Coal per Kw-hour.
May	258,446	20,840	12.40
June	292,053	18,360	15.90
July	215,485	18,440	11.68
August	234,856	22,810	10.30
September	256,614	29,840	8.65

The men have earned a premium each month since the premium rules were put in force which amounts to a substantial increase over their previous wages. This, of course, insures their continuous active interest in everything which pertains in any way to fuel economy about the plant.

Electrolytic Recovery of Zinc.

A process for the electrolytic recovery of zinc has been worked out by Mr. Chitaro Yoshido, the proprietor of a copper mine in Iwashiro province, Japan. The zinc ore is dissolved in the electrolyte, and from this liquid the zinc is precipitated by electrolysis. One of the defects of the process has been the spongy form of the zinc, which adhered to the cathode. To prevent this, carbon instead of lead was tried in the anode. The carbon was coarse and dissolved in the sulphate of zinc, and the zinc which gathered on the cathode was then found to be refined to a high degree.

Letters on Practical Subjects

LAMP-CORD ADJUSTERS.

The following device has been found very useful for droplights, as it not only takes up the slack in the cord, but permits the placing of the lamp at almost any point of the room. On the two end walls of the room, near the side walls, about 7 ft. or 8 ft. from the floor, fasten four hooks. Through these hooks run an endless cord (chalk line is very serviceable). This cord must be sufficiently slack to enable it on one side to be looped around the slack of the lamp cord and on the other side to be doubled through a Fahnestock connector fastened by some means to the lamp socket. The loop through the connector can be shortened or lengthened to lower or raise the light.

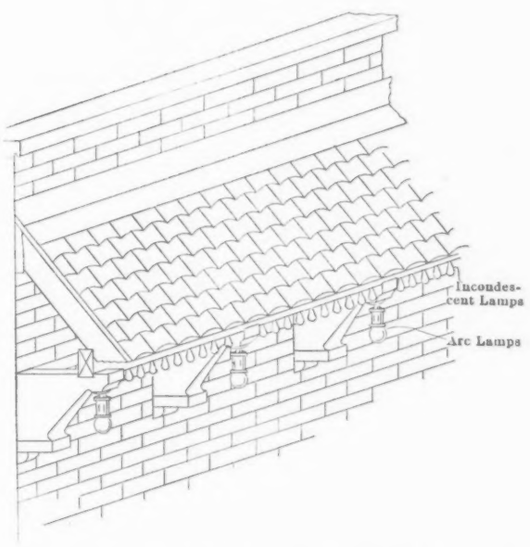
It usually takes some experimenting to determine the lengths of cord, and also of lamp cord, that will give best results; but it is possible so to adjust the two that the lamp can be moved almost in a flare all over the room. The lamp will stay anywhere it is placed.

Lafayette, Ind. E. E. GEORGE.

EFFECTIVE BUILDING-FRONT ILLUMINATION.

The lighting scheme for a store front described below is entirely new to the writer at least, and it certainly is effective as concerns attracting unlimited attention and illuminating the building. Only one short block distant from the arrangement shown is another large building which has its front lighted by several flaming arcs which are suspended upon cantilever fixtures above the roof in such a manner that light from the lamps is thrown against the front of the building, while the lamps are swung back over the roof during the daytime and for the purposes of trimming, etc.

The second method is only mentioned for the sake of comparison with the system about to be described, for, while the cantilever system is effective and does its work, the arrangement of lamps is certainly an eyesore by daylight, and the owner of the building very quickly learned that it was to his interest to keep the lamps swung back out of sight during the day. On the other hand, the system illustrated is very pleasing by daytime as well as by night and adds greatly to the appearance of the building. A porch roof was thrown across the façade of the building, brackets were placed 8 ft. apart, and between each pair of brackets were placed eleven incandescent lamps. The brackets were made 8 in. wide upon the face and a large inclosed-arc lamp was attached thereto, projecting downward in line with the row of incandescents.



Method of Lighting a Building Front.

The illustration shows the lamp scheme quite clearly, the arc lamps being located upon the brackets and serving as drop ornaments and the incandescent globes being connected between each pair of brackets.

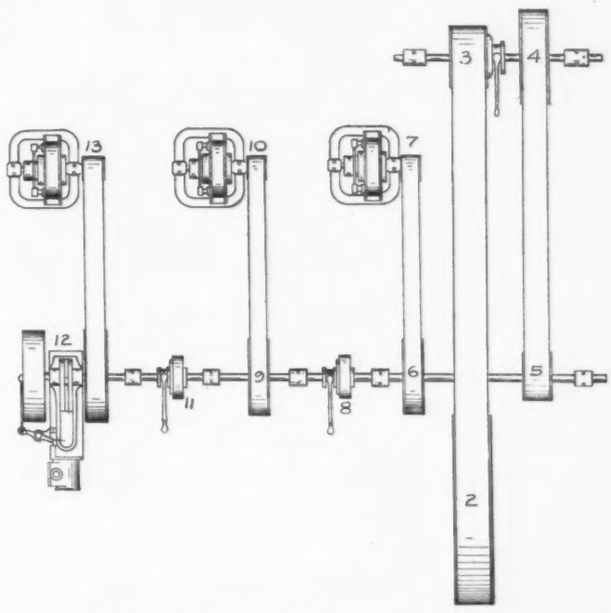
Although not shown by the engraving, being omitted for the sake of clearness, the row of small lamps is returned at the end of the facier and extends back to the wall of the building. This novel lighting display has recently been added to a store building in South Bend, Ind. The architects transformed the structure from an old hotel originally erected for a farm building into a business block, stucco-finished and presenting every appearance of a modern structure of massive and imposing frontage.

South Bend, Ind. HOWARD JOHNSTON.

THREE-BELT-DRIVEN DYNAMOS.

The illustration shows a convenient arrangement of belts, shafts and dynamos, located in a shop that requires a few lights every day and a large number on cloudy days as well as during the latter part of the short days in early winter. The main engine has a stroke about twice the diameter of cylinder and turns about 90 revolutions per minute. There are two flywheels on the crank shaft, one of which is shown at 2. The belt on this wheel drives the friction clutch pulley 3. When this clutch is in it turns 4, which is belted to 5, and as this gives motion to 6 the dynamo 7 generates enough electricity for the everyday load. The cut-off coupling 8 is out a greater portion of the time, but if more capacity is required it is thrown in, causing 9 to drive 10 while 11 is pulled out.

This is sufficient for all ordinary purposes, but if still more capacity is wanted for special service the medium-speed engine 12 is started to drive 13. If a few lights are wanted at night for repair work while the main engine is shut down, 12 is run to operate 13, and, of course, 11 is out; if, however, one dynamo is not sufficient 11 is thrown in to drive 9 and 10 while 8 is out.



Convenient Arrangement of Belts, Shafts and Dynamos.

This arrangement has proved satisfactory for a long time, and although such a drive is considered behind the

times, yet the cost of fuel for operating it and the expense for repairs will compare very favorably with many high-speed direct-connected units which are rated as up-to-date.

New Haven, Conn. W. H. Wakeman.

EFFECT OF LEADING AND LAGGING CURRENTS ON THE REGULATION OF ALTERNATORS.

The regulation of an alternator is defined in one sense as the change in voltage from no-load to full-load divided by the full-load voltage. It is known by experience that when an alternator delivers lagging current its voltage falls in passing from no-load to full-load, whereas if it be connected to a circuit drawing considerable leading current its voltage rises as its output increases. The object of this article is to give an explanation of this action without the use of vectors or mathematics.

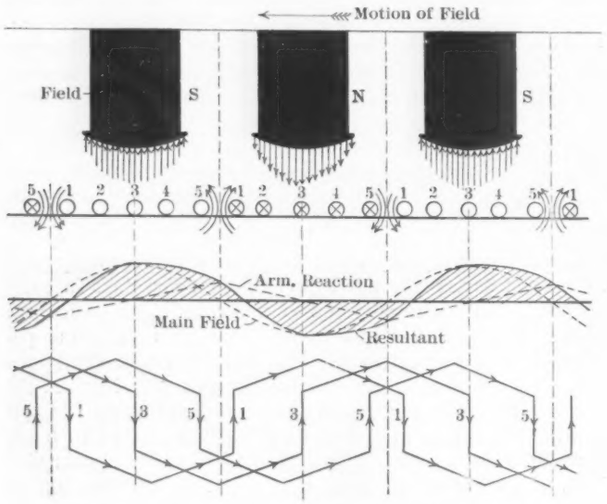


Fig. 1—Action at 100 Per Cent Power-Factor.

In Fig. 1 the poles of a revolving field alternator—single-phase for simplicity's sake—are shown with the armature conductors in section, a dot signifying current flowing out and a cross current flowing in. The field forms and a portion of a simple wave-wound armature having all the conductors in series are also indicated. The poles are moving from right to left and the flux sweeping across the conductors tends to produce currents in them flowing from the observer beneath the north poles and toward him under the south poles.

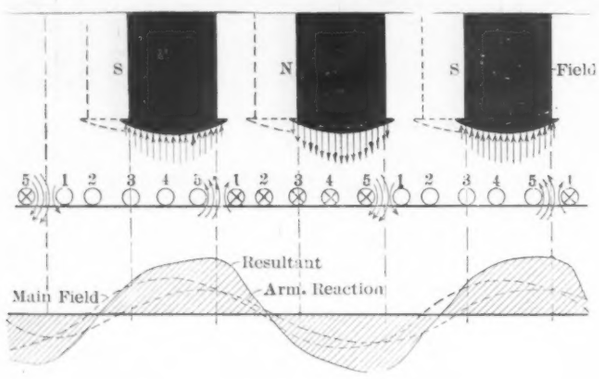


Fig. 2—Action with Leading Current.

At no load no current will exist in the armature and the voltage of the alternator will be proportional to the number of lines of flux cut per second by the armature conductors. The only flux to be cut is that produced by the main-field winding.

Now suppose the alternator to be loaded by supplying current to a circuit giving 100 per cent power-factor. This current flowing around the iron core of the armature produces a flux the maximum value of which occurs at a point midway between the poles, for at the instant shown in Fig. 1 all the conductors on the armature are cutting flux of correct polarity to give the maximum voltage at the terminals, and thus at this instant the maximum value of current also occurs, since the generator is operating at 100 per cent power-factor. The reaction flux is equally distributed between the field poles, and a resultant field similar to that shown is obtained. The field form has been shifted against the rotation of the poles, and the No. 1 conductor of each group is now cutting flux of opposite polarity to that at no-load. This would tend to reduce the voltage, but conductor No. 5 is cutting a field of correct polarity, which has increased in strength by an amount equal to the decrease at No. 1. Likewise, the increased flux cut by No. 4 is compensated by the decreased amount cut by No. 2. Thus, there would be no drop in the *induced* voltage from no-load to full-load.

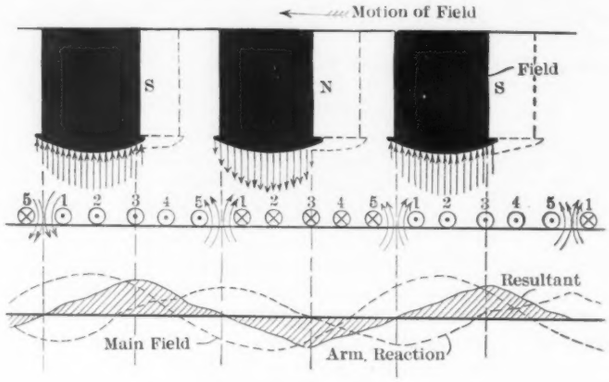


Fig. 3—Action with Lagging Current.

Consider now the effect of a leading current. In this case the maximum value of current, instead of occurring at the instant of maximum voltage, comes before the field spools have reached the position of Fig. 1, which is shown in dotted lines in Fig. 2. The value of the armature flux has been increased by having the reluctance of its path decreased. The lagging of the field behind the current (leading current) places the field cores in such a position that the armature flux has an easier path, and consequently its value is greater than in Fig. 1; and it may be noted that it is assisting the main field, thereby resulting in an increase of voltage from no-load to full-load, since the total value of the flux to be cut has increased from no-load to full-load.

Fig. 3 shows the effect of lagging current. In this case the maximum value of the field flux sweeps across the middle conductor of each group before the current has reached its maximum value. Again, the armature reaction flux is increased by having the reluctance of its path lowered, but in this case the effect is to reduce the total field flux and consequently the voltage.

To sum up: (1) A leading current produces an armature reactive mmf which aids the main field and boosts the voltage from no-load to full-load; (2) a lagging current gives a reactive flux which opposes the main field and cuts down the voltage from no-load to full-load.

Schenectady, N. Y. Bayse N. Westcott.

SHORT METHOD FOR FINDING THE HYPOTENUSE OF A RIGHT TRIANGLE WITH THE SLIDE RULE.

The problem of finding the hypotenuse of a right-angled triangle when the legs are given may be solved on the slide

rule more readily by the following device than by the method of taking the square root of the sum of the squares.

The formula $P = \sqrt{m^2 + n^2}$ (in which m and n are the legs and P the hypotenuse) is not suited for logarithmic or slide-rule work because of the addition which is required. It is rendered more suitable, however, if the right-hand member is multiplied by the factor m outside the radical and by $\frac{1}{m^2}$ under the radical. This puts it in the form

$$P = m\sqrt{+1\left(\frac{n}{m}\right)^2}$$

This is more suitable for slide-rule work, since the only addition now required is the addition of unity; and if the smaller of the legs is used for the numerator in the fraction $\frac{n}{m}$, the value of $\left(\frac{n}{m}\right)^2$ will be less than unity and the addition is reduced to the annexing of unity before a decimal.

With the legs given, we solve the problem as follows: Divide the smaller by the greater, using the "C" and "D" scales. This gives the quotient $\frac{n}{m}$ on the "D" scale and $\left(\frac{n}{m}\right)^2$ may be read on the "A" scale. Anex unity to this decimal and set the end of the slide to the value of $1+\left(\frac{n}{m}\right)^2$ on the "A" scale. The end of the slide will then be set at $\sqrt{1+\left(\frac{n}{m}\right)^2}$ on the "D" scale, and by setting the runner at the value of m on the "C" scale, the value of the hypotenuse may be read on the "D" scale. The only setting of the rule required is that for one division and one multiplication.

Wilkinsburg, Pa. JOHN S. HOLLIDAY.

A DIRECT-READING DYNAMOMETER.

In the testing of electrical machinery there is usually a serious disadvantage in the measurement of mechanical power, the lack of instantaneous readings. The methods used for the dynamometric measurement of power either integrate values over a time interval—like the steam-engine indicator card or the Starrett speed indicator—or require manipulation, like the slide-wire bridge. The ordinary transmission dynamometer for measuring the power transmitted through shafting is of the latter class.

If the relative angle of advance of the two disks of the dynamometer be made to vary the resistance of a resistor, there is afforded a method of reading instantaneous power by a voltmeter, ammeter or indicating ohmmeter. The essential features of the transmission dynamometer usually take the form of two co-axial shafts, connected by a helical spring, and two disks flanged on to the ends of the shafts next to the spring. The relative angular advance of the driving disk over the following disk is a measure of the power, or, more strictly, torque.

Consider two points on the disks opposite each other at zero speed. At the point on one disk provide it with a light spring, adapted to touch the corresponding point on the other disk. Beginning at this second joint, wind a circular resistance wire on the face or edge of the disk through nearly 360 deg. Connect the beginning of this wire and the spring to a collecting ring on each shaft. None of the resistance wire will be in circuit at zero torque. As the torque increases more of the resistance will be in circuit up to the limit of the instrument, nearly a full revolution. If a source of constant emf be applied to the slip-rings and the current be measured by an ammeter calibrated inversely in foot-pounds, the torque may be read directly and instantaneously at any time.

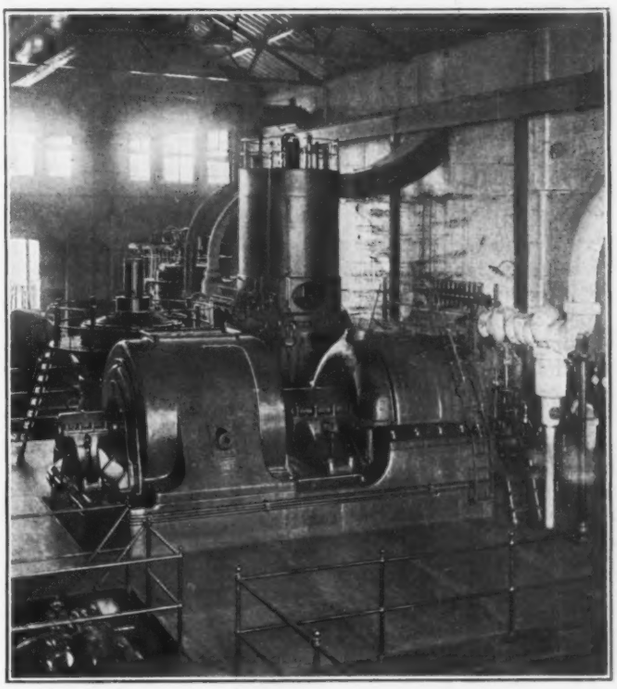
The current decreases as the torque and resistance increase, but for a given constant voltage the ammeter may be calibrated in foot-pounds as easily as the circumference of the ordinary fixed dynamometer disk is calibrated in foot-pounds.

Using this method in connection with a speedometer and the usual electrical meters, speed, torque, voltage, current, etc., may be read simultaneously and frequently.

New York, N. Y. A. G. BRADBURY.

ROTARY CONDENSER RECONSTRUCTED FROM A TURBO-GENERATOR.

The generating station of the Omaha Electric Light & Power Company contains 13,000 kw in turbine-generator equipment, made up of one 4000-kw horizontal and two 3750-kw and one 1850-kw vertical Curtis General Electric sets. The Omaha company has a large motor load among grain elevators and other local industries, totaling nearly 11,000 connected hp. The effect of this heavy motor load has been, of course, to lower the power-factor of the station output, increasing the heating of the machines and affecting their efficiencies. In the Omaha station this reduction of power-factor even reached a point where it was difficult to get sufficient excitation to hold up the rated terminal voltage of the alternators.



Rotary Condenser (at Left of Horizontal Unit) Reconstructed from Turbine-Type Generator.

A 2200-kva generator in the plant had become available for other uses at about this time, due to the installation of larger units, and it was accordingly determined to reconstruct this machine into a synchronous motor, operating it as a rotary condenser to improve the station power-factor. For its new rôle the unit was equipped with a special shaft and roller step-bearing, the work of reconstruction being done at Omaha from plans prepared at the factory, the additional parts having been dispatched for carrying out the changes.

When completed the machine was set up in place alongside the horizontal unit, behind which it is seen in the illustration. In appearance at a casual glance it still resembles, of course, its former turbo-generator chrysalis stage, for which it might easily be mistaken. The result of installing the rotary condenser, however, has

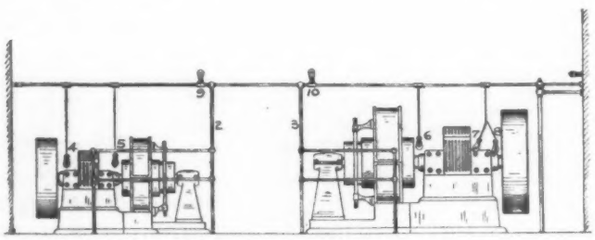
entirely corrected the former troubles due to low power-factor, the leading currents taken by the over-excited motor offsetting the lagging characteristics of the outside load. This rotary condenser installation has now been in successful operation about twenty months.

Omaha, Neb. James Hazerick.

LIGHTING OILERS ON HIGH-SPEED ENGINES.

Although my engine-room was well lighted so far as overhead and wall lights were concerned, more or less trouble was caused by lack of light bearing directly on the oilers, as when one of them failed to feed fast enough it was not discovered until the bearing was too warm for good practice.

The illustration is the elevation of a simple device adopted to overcome this objection. It has a good appearance and gives satisfactory results. A line of conduit was carried from one wall to the other, with suitable outlets for the required lamp connections. As this line required sup-



Lighting Arrangement for Engine-Room.

ports near the center, two railing posts were carried up for this purpose, as shown at 2 and 3. These are made of 1-in. pipe, and the conduit is a loose fit in the pipe which connects these posts at the top in order to strengthen the railing.

Lamps are suspended behind oilers on the main bearings at 4, 5, 6 and 7, while 8 lights one that feeds an eccentric. Lamps of 5 cp or 6 cp are sufficient to enable an engineer to see how his oilers are working without going close to them, and this is both safe and convenient in practice. Two 60-watt tungsten lamps are shown at 9 and 10. They are serviceable and ornamental.

New York, N. Y. John Foran.

INSTALLATION OF MOTORS IN DIRTY PLACES.

Electric motors operate so well under many adverse conditions that it has become the habit of purchasers and of some consulting engineers to let them bear all they will instead of mitigating the conditions so that the motor may operate under as favorable circumstances as possible. This is especially true as regards the protection of a motor from dust and dirt. A good motor will stand so much abuse of this kind that there seems to be a feeling that a motor manufacturer who asks that his apparatus be installed in a clean place and kept reasonably clean cannot have a good motor.

This is not the case. Manufacturers of the best motors and engineers conscientiously looking to the best interests of their clients will recommend the protection of motors as far as possible from dust and dirt, for, no matter how good a motor may be, if it will run in a dirty place it will surely run better, last longer and need less care if installed where it can be kept reasonably clean. Inclosed motors may be the solution of the problem when no other is possible. If completely inclosed, they keep out of dirt, but they keep in the heat, and no motor can run without producing heat.

Inclosed motors are necessarily large and costly, and they will never receive the care given to open motors, because the working parts are concealed, and hence are rarely inspected, except in case of actual failure. Besides, to cut down the first cost, they are usually allowed to run at higher temperatures than open motors, with the result that their insulation is subject to greater deterioration. In recognition of this the standard specifications adopted by most motor builders permit a rise in temperature of 40 deg. C. for the windings and 50 deg. C. for the commutators of open-type machines, while the standard for inclosed-type machines is 15 deg. higher for the windings and 10 deg. higher for the commutator, and the manufacturers of motors do not make overload guarantees on the inclosed machines.

Boxing up an open motor is equivalent to inclosing it, both in confining the heat and in concealing it from the daily or hourly observation that one unconsciously gives an open motor in passing by it, as some attendant, workman or superintendent will always do several times a day. But in many industries, such as foundries, grain elevators and coal-handling establishments, dust cannot be avoided, and yet motors must be installed to work continuously and reliably and without unreasonable care. These are the motors that are allowed to accumulate great quantities of dust and condemned if they fail on account of this condition.

Many motors do not fail even though their windings and ventilating ducts may be full of dust, because they are not worked continuously or are not worked at a heavy load; and on this account the motor manufacturer is many times blamed because a fully loaded or overloaded motor will not stand the same conditions.

One can hardly expect motors in such places to be cleaned more than once or twice a day, although much greater attention would be given to a steam engine, or almost any other class of machinery, as a matter of course; yet a few moments' attention at least once a day is not too much to expect, and it would take but a very little time when starting the motor in the morning to brush off from the frame the dust that accumulated the day before, and to blow out from the windings and from the air ducts with a small hand bellows enough of the accumulation to keep them from being choked up entirely. At the same time a careful motor attendant will see that there is plenty of oil in the bearings (without putting any more in to run out on the floor if the oil-well is already full) and will see that the oil rings turn when the motor starts up and that the brushes are long enough and are free in the holders. If this is done, the motor is good for a day's run practically without further attention.

Motors in dusty places generally accumulate an entirely needless amount of dust and dirt, because if it is not possible to give them complete protection they generally receive none at all.

A light platform or canopy a few feet above the motor will keep off perhaps two-thirds of the dust, as most of it settles down from above; a barrier a few feet higher and a little wider than the motor, raised from the floor, will often shield it from a lot more, and in this way the daily cleaning, even in very dirty places, will often be reduced to a very small matter. Barriers raised from the floor are especially effective in wood-working plants, where shavings and sawdust are usually projected in a definite direction from the machine producing them and can therefore be easily intercepted.

Intelligently placed barriers and canopies with a reasonable amount of attention will be found to solve most of the troubles connected with installing motors in dusty places in a comparatively inexpensive manner. They will also save the customer many an unnecessary repair bill and will relieve the motor manufacturer from much undeserved blame.

Chicago, Ill. M. O. Southworth.

Questions and Answers

We are desirous of obtaining an insulating material which will not burn, crack or melt at a temperature of 1500 deg. Fahr. Can you suggest any substance for this purpose? M. B.

It is probable that the best insulating material to use to withstand the temperature mentioned is quartz. This can be obtained from chemical supply houses.

We have recently changed over from a 133-cycle system to one having a frequency of 60 cycles. Most of the meters are of the 133-cycle type of various makes and doubtless are incorrect on the lower frequency. What changes are necessary to guard the company against loss? R. A. S.

The manufacturers of the various meters can best advise you on this subject. It may be possible to retain the entire equipment by substituting 60-cycle coils for the 133-cycle coils now forming part of the meters. The iron losses in the meters will be different with the lower frequency.

I have a small commutator-type, 110-volt, 133-cycle motor which I would like to rewind for 60-cycle service. What size of wire should be used and how many turns per coil are necessary? Will it be necessary to rewind the field coils also? J. A. N.

A commutator motor designed for 133 cycles will operate with improved power-factor and efficiency when run with 60-cycle current. The exact improvement cannot be directly predicted, but it can safely be stated that if it is to be operated at the same voltage as formerly it should be provided with a slightly larger number of turns per armature coil and per field coil and a slightly larger wire in each case.

A telephone line 30 miles long and consisting of a pair of No. 10 hard-drawn copper wires is built according to standard practice. From one terminal to within 1¼ miles of the other terminal the line follows a straight path and then makes a right-angle turn and for the rest of the way forms part of a 200-pair submarine cable terminating in the office with a condenser in series with each side. Near this end of the line and within the angle made by the telephone wires is a high-power wireless station, which when in operation practically renders the telephone line useless because of the noise. What can be done to remedy this condition? A. O'S.

The trouble is purely electrostatic, and relief will be afforded by running the wires in twisted pairs, lead-covered, for a distance of 500 ft. or more either side of the wireless station.

A 110-volt, four-pole, 60-cycle induction motor at present used as a fan is to be employed for driving a washing machine when rebuilt. It is wound with 280 turns of No. 22 single cotton-covered wire per coil, has a bore of 3¾ in. and a frame 1½ in. wide. The rotor has thirty-seven copper bars. Would it increase the power of the motor if the frame and rotor were made 3 in. wide? What would be the winding data? A. J.

If the length of core of an induction motor is increased by 100 per cent and the length of coils is correspondingly changed, without any change in the number of turns per coil or in their distribution, the machine will operate at normal flux density when subjected to twice the initial voltage and will be capable of carrying twice the former rated load. If it is desired to operate at the initial voltage, then the number of turns should be decreased to one-half the former value and the cross-section of the conductor should be doubled.

Our transformers are banked on the secondary side, feeding a three-wire, 220-volt system. By changing them so that each transformer carries its individual load we can save considerable wire. Will the advantages of the former method of operation compensate for the extra wire used? A. G.

There are two advantages in banking transformers on the secondary side, rather than having them feed energy to individual loads. One of these relates to the possible saving in transformer equipment by reason of the fact that the transformers may not all be loaded simultaneously, and the other to the increased reliability of service by reason of the fact that the transformers assist each other in carrying the load, when otherwise one of them might be seriously overloaded. From your inquiry it would seem that you find a considerable added expense in extra wire when using your transformers banked instead of connected to individual loads. In your case it would probably prove advantageous not to bank the transformers, although you would probably lose a certain amount in decreased immunity from interrupted service.

Is the two single-phase wattmeter method of measuring three-phase power entirely accurate, or as accurate as with a single polyphase meter, particularly where open delta connections of transformers are used? B. F. D.

The two-wattmeter method of measuring power is absolutely accurate for any three-wire system whatsoever, whether it be single-phase, two-phase, three-phase, balanced, unbalanced or otherwise. It is essential merely that the current coils of the two wattmeters be inserted in two of the line wires and the two shunt coils be connected between these two line wires and the third wire. When the power-factor of the load on a three-phase system is less than 50 per cent one of the wattmeters or one of the watt-hour meters used in the two-meter method of measuring power or energy would give a negative indication. That is to say, one of the wattmeters would reverse its readings or one of the watt-hour meters would tend to rotate backward. The mere change in the connection of the wattmeter would cause it to show a positive reading on the scale. In the case of the watt-hour meter the instrument would be subjected to a reversed torque, but might not revolve in the reverse direction on account of frictional torque, which is ordinarily compensated for rotation in one direction but not in the other direction. For this reason a polyphase watt-hour meter is preferable for measuring energy in a three-phase circuit to two single-phase watt-hour meters. However, the sum of the readings on two watt-hour meters, taking care of the negative reading in case one meter reverses, should show with a fair degree of accuracy the amount of energy consumed by the load.

A 5-hp direct-current motor with four poles, eighty-eight commutator bars and forty-four slots in the armature has laminated core and field pole pieces. At normal speed of 1100 r.p.m. it produced 120 volts. We connected up three taps to the armature winding, brought them out to slip-rings and speeded the machine to 1800 r.p.m. We excited the fields fully from an external source. The taps are connected on to leads that went to bars 1, 30 and 59 respectively. We can obtain only about 60 volts alternating current at most with this arrangement. The throw of the present winding is about one-quarter of the circumference. We were planning to rewind the armature, disconnecting the direct-current commutator entirely, and should be obliged for advice as to whether we should divide the armature up into poles, changing the throw of the coils to about one-sixth, and if it would be advantageous to connect up the armature with Y-connection instead of delta. The present pole shoes fully cover nine armature slots and leave two slots between each two poles. W. H. S.

The four-pole machine described as having forty-four slots in the armature and eighty-eight commutator bars has evidently been so designed that the coils can be connected to the commutator according to the lap method to produce 120 volts and according to the wave method to produce 240 volts. It is evidently now connected according to the lap method, because it produces 120 volts. The winding can be arranged according to the lap method by utilizing eighty-seven of the coils and leaving one coil dead. If operated with normal excitation at 1100 r.p.m. the machine should then give about 240 volts as a direct-current machine. Numbering the active bars consecutively from 1 to 87, the machine can be operated as a three-phase generator by connecting taps to bars 1, 30 and 59. Under these conditions the emf between taps should be about 145 volts. By increasing the speed to 1800 r.p.m. the electromotive force should be about 240 volts. Unless we have misinterpreted the data given in your letter the machine thus reconstructed and operated should prove suitable for providing 220-volt, three-phase, 60-cycle current.

Central Station
Management, Policies and Commercial Methods

PRACTICAL ELECTRIC BAKING AT MILWAUKEE.

The Skiles Bakery, of Milwaukee, Wis., which has had a 10-kw, eighty-loaf electric oven in service several months, as noted in our issue of Aug. 19, 1911, page 448, is now preparing to install a 30-kw, 360-loaf oven. The local

Eighty-Loaf Electric Oven in Milwaukee Bakery.

experience with the smaller Simplex apparatus, illustrated herewith, has convinced Mr. Skiles that, compared with the ordinary coal-heated affair, the electric oven has the advantages of saving coal and ash-storage space, the expense, labor, dirt and annoyance of handling coal and ashes, unpleasant heat in the workrooms, etc. The electric ovens, which are built on the multi-story plan, occupy only one-fifth the space of the old ovens, and can be started up much more quickly, attaining a baking temperature within forty-five minutes after the heat is applied.

The new 360-loaf oven, which is being built by the Westinghouse company, will have a maximum demand of 30 kw and a running demand of 20 kw. It will be in use twenty hours a day, as in the case of the present unit, assuring a consumption of about 20,000 kw-hours per month. Under these conditions the bakeshops will earn a rate of 2¾ cents to 3 cents per kw-hour, the energy cost for baking amounting to about ⅛ cent per loaf. Wheat bread requires thirty minutes to bake, so that the large oven will produce 720 loaves per hour, or 14,400 per day. Rye bread requires a higher temperature, the "medium" heat, for "maintaining," and the "high" heat during forty-five minutes for baking

One of the greatest attractions of electric baking in the case of the Skiles bakery has been the advertising afforded, and the noticeable increased business which resulted following the announcement of the use of the electric oven. This advantage is felt to have offset fully the slightly higher cost of operation of the electric oven. Final proof that the owner considers it a good investment is afforded by the present plan to install an additional and much larger apparatus, giving a total capacity of more than 15,000 electrically baked loaves per day.

Electricity is used generally for other operations throughout the Skiles bakery, motor-driven dough-mixers, cake-mixers, etc., being employed for preparing the flour, etc. Mr. M. F. Flynn, the heating specialist of the Milwaukee Electric Railway & Light Company, which supplies the electrical energy, is now also about to apply inclosed chafing-dish heating units to the frying pots in which the lard and cottonseed oil is kept boiling for dipping doughnuts. It is the common practice to heat these pots over open flames, and if the hot oil boils over bad fires may result. The application of electric heat will remove this danger and further lower the insurance rates, which discriminate in favor of electric heating.

LETTING THE CUSTOMER ESTIMATE HIS OWN WIRING COST.

In its attractive new booklet, "Electric Wiring of Old Houses," the Cleveland Electric Illuminating Company encourages prospective customers to make use of the wiring data it supplies, and thus estimate the cost of equipping

CLASSIFICATION OF LIGHTS

LOCATION	Center Outlet	Side Outlet	Base Receptacle	Drop Cord Key Sockets	Drop Cord Chain Sockets	Single Pole Switches	3-Way Switch	Snap Switches	4-Way Switch
Porch									
Vestibule									
Reception Hall									
Reception Room									
Living Room									
Library									
Dining Room									
Lavatory									
Pantry									
Kitchen									
Basement									
Rear Hall									
Upper Hall									
Upper Rear Hall									
Bath									
N. E. Chamber									
S. E. Chamber									
N. W. Chamber									
S. W. Chamber									
Closets									
Third Floor									
Totals									

Name_____ Address_____

Have contractor call_____

Sheet for Estimating Wiring Cost.

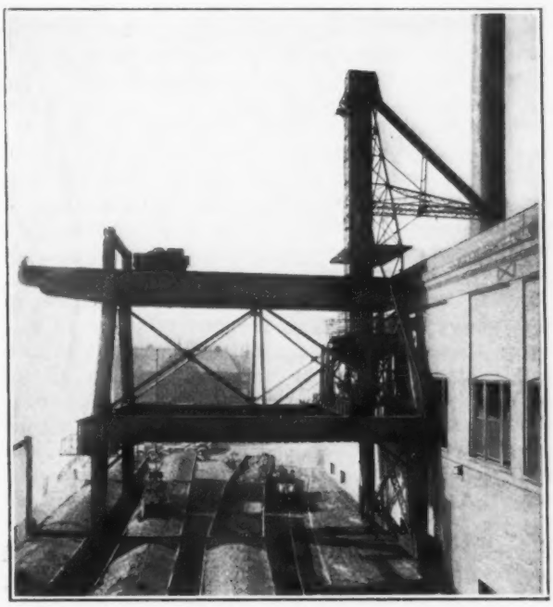
their own homes with electricity. Several pages of the book are occupied with illustrations and arguments concerning the advantages and conveniences of electricity in the household; then follows a glossary of terms of electrical fittings, and finally a price list of the cost of material

and wiring per outlet on the Cleveland unit plan already mentioned in these columns. The last page of the booklet is a perforated sheet bearing a tabulated statement of the various rooms of an average dwelling, with columns for marking in the type of outlet used, kind of switches, etc. If the customer desires, he may refer to the price lists and estimate the cost of the work he has in mind, or he may mail the perforated page to the company's office, marking on it his name and address, and suggesting a date for the company to send its representative or contractor to call. All estimates are furnished, of course, without obligating the householder in any way.

HAULING COAL FROM A LIMITED YARD AREA AT TOLEDO.

At its Water Street generating station the Toledo Railway & Light Company burns about 450 tons of coal a day during the winter months. This quantity must be handled from the restricted quarters of the narrow yard between the plant building and the waterfront, the three "dead" tracks of which will hold no more than a dozen cars. The company maintains a large coal storage at one of its railway barns, about 2 miles distant, but the expeditious delivery of this coal to the plant in spite of the space limitations is, of course, of the greatest importance.

The first coal-handling equipment installed at the Toledo station comprises a 50-ft. gantry carrying a boom crane, the grab bucket of which can be hoisted up over the crusher



Gantry Coal-Unloading Crane at Water Street Plant, Toledo, Ohio.

hopper at the opposite end of the bridge. From the crusher the coal is delivered to an inclined bucket elevator, from which it is discharged down a sloping chute to hatches over the plant belt conveyor, distributing it to the bunkers.

A new coal-handling crane of the gantry type has just been installed, as illustrated in the photograph. The 50-ft. bridge spans three tracks (one of which is kept clear for traffic) and overhangs a fourth. The crane bucket dumps into the crusher hopper at the right, through a coarse protecting screen, shown opened. From the crusher a screw conveyor carries the finely divided coal into the vertical bracket elevator, from which it is delivered through the down-chute on to the plant conveyor.

One 45-hp and one 35-hp, 500-volt direct-current motor are provided for the hoisting service, the larger motor acting to close the bucket through the coal, although both motors are utilized in hoisting. A 10-hp motor drives the trolley across the bridge and a 45-hp motor, acting through a system of driving rods and gears, propels the gantry along its rails, 50 ft. apart. The bridge has a total travel of nearly 400 ft. and can be used to spot cars if desired. A single 20-hp compound-wound motor drives both crusher and elevator. The crusher can be by-passed if slack or crushed coal is to be handled directly from the cars.

All of the motors on the crane are controlled directly from the operator's cab at the left of the lower chord, which commands a clear view of all operations of the machine. Plain rheostatic control of the hoist motors is employed, but these motors are arranged for dynamic braking when lowering, dissipating their energy of rotation in resistors. Solenoid-opposed spring brakes are also provided, and limit switches are arranged to prevent overtravel of any part.

The unusual size of this coal-handling crane may be best appreciated by its over-all dimensions. From the gantry runway to the rails on which the trolley hoist runs the height is 54 ft., while the extreme height to the top of the elevator head is 100 ft. from the ground.

The crane was originally designed by its builder, the Toledo Bridge & Crane Company, to handle 75 tons to 100 tons an hour, but tests in service have shown it to unload a 50-ton car in twenty minutes, including the time required to "trim" and shovel the last of the coal into the bucket. On another occasion 100 tons was delivered to the bunkers from the cars in forty minutes.

DIVISION ORGANIZATION OF COMMONWEALTH EDISON N. E. L. A. SECTION.

In addition to its general meetings, plans have been perfected for the organization of two divisions of the Commonwealth Edison Company (Chicago) Section of the National Electric Light Association. These are a technical division and a commercial division. Other divisions may be formed later, possibly. The affairs of each division are managed by a division chairman, a vice-chairman and three other members appointed by the division chairman. This committee co-operates with the section chairman of the entertainment committee for all of its meetings. These division committees are as follows: Technical division, Mr. P. B. Juhnke, chairman, and Messrs. W. C. Berry, A. G. De Clercq, E. W. Grover and N. J. Conrad; commercial division, Mr. O. R. Hogue, chairman, and Messrs. W. C. Berry, W. P. Lyon, G. H. Jones and G. B. Johnson. Mr. Berry, as vice-chairman of the whole section, is ex officio vice-chairman of each division committee.

Meetings of the technical division are planned for January, March, May and September, and of the commercial division for February, April, June and October. In the technical division the general subjects for the four meetings are "Progressive Developments in the Generation and Utilization of Steam in Central Stations," "Recent Improvements in Electrical Generating and Converting Apparatus," "Latest Transmission and Distribution Practice," and "Subjects of Special Interest in the Different Branches of Central-Station Service." The commercial division program includes these general topics: "Rates for Electric Service and Relations with the Public," "The Sale and Introduction of Electric Power," "The Sale and Introduction of Electricity for Lighting Purposes," and "The Sale and Introduction of Electric Heating Devices and Other Current-Consuming Appliances."

The formation of these two divisions does not conflict with the general meetings of the section, which will be addressed on subjects of wide general importance by such men as Judge Peter S. Grosscup, Mr. Samuel Insull, Mr. B. E. Sunny and Mr. B. I. Budd.

THE SALE OF ENERGY FOR ELECTRIC POWER.

By Luther P. Perry.

"Power load" is the slogan ever being repeated by operating men, salesmen and executive boards of electricity supply companies. It is generally recognized that this issue will be of paramount importance until central-station load curves show as great an output during the daylight as during the early evening hours. Yet to-day, when most lighting-plant operators picture this ideal condition as a great way off, there are springing up all around mammoth enterprises whose only function is the supplying this very day-motor load which a few years ago was considered but an incidental of the lighting business. Therefore there are reasons for believing that when the central-station superintendent has at last approximated the ideal load curve previously mentioned those who are responsible for dividends will not allow matters to stop there but will put great emphasis upon the securing of all possible day load, even to the extreme of making the lighting business appear as a secondary consideration. As an illustration of the present trend, one need only mention the increasing number of allusions to commercial motor service appearing in prospectuses of companies endeavoring to float bonds and stocks. Therefore, a consideration of the methods of securing this load is timely.

ORDER OF ATTACK.

In manufacturing cities of any considerable size it is not practicable to make a door-to-door canvass. There are more effective and more enjoyable ways of obtaining better results. There are strategic times for opening negotiations with prospective consumers, at other than which efforts would avail comparatively little; time and energy would be squandered. Let the salesman center his attention on that prospective customer with whom he is most likely to obtain results; the future will bring similar occasions when other customers can be approached with the same advantage.

The easiest of all contracts to close is for the future energy supply for buildings under construction; but once an isolated plant is installed action is likely to be delayed for several years unless a market be found for the generating equipment to be discontinued. The plant will hardly go in, though, if one keeps after the owner with deserved confidence in the superiority of his commodity, offering to engineer the electrical installation, demonstrating the advantage of operating a year or two on purchased energy prior to the making of a definite decision to install a private generating plant, pointing out local concerns purchasing energy for lighting and motor service, and possibly composing a detailed report to show the relative costs of operating with a new plant or with central-station supply. The prize at stake warrants the insistence of the proverbial book agent, and the client will certainly thank the salesman after once experiencing the excellence of the service supplied.

But endeavors do not begin and end at competing with proposed new isolated plants, for there are always to be found apparently satisfactory equipments that have been in use for a number of years. Their owners see little reason for making changes involving the purchase of energy, for the belief is current among laymen that lighting companies are producers of an expensive luxury adapted to lighting but not for extensive motor service.

An especially good time for the central-station representative to introduce himself and his wares is when there is a change of management. The new executive is then optimistic over his own ability to work innovations in his plant, and he is ready to look into any phase showing some probability of bringing about an improvement. He is not so certain that everything in the plant is as it should be, and is very likely to listen to suggestions in an open-minded way. The result is a future, if not an immediate, application. Some day this factory manager is likely to call upon the central-station man for assistance.

Newspapers and local industrial journals frequently announce real-estate transfers, make allusions to building additions and the organizing of night shifts, and advertise for new or second-hand motive equipment. Many of these activities afford just the opportunity for one to offer gracefully to be of such assistance as he may in supplying temporary auxiliary or additional energy for light or motor service. Once he has gained entrance he will secure permission to inspect the property, after which he will have suggestions as to a few proper applications for his commodity. In case the management of the mill shows progressiveness and should complete electrification seem feasible within a year or more, the representative should by all means secure permission to make a complete power investigation. The result of this, if not an immediate contract, is to educate the management to the realization that central-station energy is better than and as cheap as or cheaper than that produced by his existing isolated plant. Once central-station energy receives the credit of being practical for an installation, the battle is half won. The future is bound to shape things to favor the purchase of outside energy.

There are times when it seems as if all good prospective customers have been shelved and that there is no advantageous opening to develop. At such times one should go ahead and make an opening. If one is not at all acquainted technically with the enterprise which he is to approach, it is a good idea to acquire first some general information, because his customer will very likely judge of his ability by the amount of intelligence he shows in the discussion of the business. One of the most effective ways to stimulate the customer's interest in the proposition is to give him an idea of what others are doing with this same service, and to draw a comparison between the reliability and economy of his plant and that of the central station. These ideas are usually so new to him that he wonders if he may not be behind the times. Occasionally a visit of inspection to the electric company's generating station starts a customer thinking and naturally increases his respect for the company's commodity.

ENGINEERING INVESTIGATION.

The less the amount of first-hand knowledge one may possess of an isolated plant, the better appear to be its economy, continuity of service and sufficiency for the work at hand. One of the great advantages of carefully prepared reports on prospective consumers is the gaining of an intimate knowledge of the relation of the existing plant to the requirements of the load it supplies. Acquaintance with the plant, its attendant, superintendent and manager, brings out many vantage points for the energy sales engineer. He learns possibly of the company's growth, of individual processes which would profit by another source of energy, of an overloaded engine, of a long-felt need for twenty-four-hour lighting and elevator service, and of many other needs that cannot be supplied with the existing equipment. Although he does not antagonize the local engineer, personal observation informs him as to how much of the plant's credited high economy is real.

His first preliminary tour of inspection over a property gives the power expert a clear idea of the general layout and the form in which his report will develop. His findings may be presented as a letter, or as a concise summary covering a few pages inclosed in a binder, or as an exhaustive, detailed discussion, including a very complete description of the plant, the results of elaborate tests and a final proposition including actual estimates made by millwrights and wiring contractors. When the relative costs of existing and proposed energy supply alone determine what action will ultimately be taken, by all means one should make a preliminary comparison of costs. He should run down a column of cost items, such as fixed charges,

material, labor, etc., and opposite each item indicate known or estimated dollars involved. Footing up the two columns, one readily knows approximately what the final outcome will be. In case central-station service has no show at all, a great deal of painstaking data and estimates may be eliminated and the report developed to show in a general way the applicability of motor drive whenever changes of drive are necessary. When an exhaustive investigation seems desirable the first thing to do is to outline the method of attack, to note subheadings as and when they come to mind, and any other points pertinent to the proposition.

All tests are likely to be influenced by the then existing rate of manufactured output; hence it is desirable to secure by months the mill output for a year or more back. With this the engine load, for instance, may be compensated to conform to the average year load. Right here it may be mentioned that it is sometimes politic to discuss power costs in the terms of dollars per unit of finished output. The automobile manufacturer's unit is cars; the baker figures in terms of mills per loaf of bread; the brickmaker so many cents per thousand.

A great number of operating steam engineers cherish the memory of a boiler test made by some consulting firm a long time ago, and the evaporation of 10 lb. or 11 lb. that was then reported is never forgotten. Yet the same stationary engineer, or his fireman, would be embarrassed if asked what the present feed-water temperature is, the exact water level, inches of draft or temperature of the flue gases, which items and many more were maintained at a set amount so that the ten-minute log of that long-ago test when plotted would follow as nearly as possible a smooth curve. The twenty-four-hour test is no criterion of the three-hundred-and-sixty-five-day efficiency of the average plant. For these reasons the power engineer would best deal in yearly costs as shown on the ledger of the bookkeeper.

When estimating the cost of material and labor to change over to use purchased energy the greatest caution must be exercised. By specifically stating what is proposed to be done and then securing an estimate from a contracting firm for the work one is protected from blame in case the projected work costs more than was estimated. Prestige can be lost in no easier way than by allowing one's enthusiasm to run away with one's better judgment in making a hasty estimate. The foregoing applies aptly to the estimating of the amount of fuel for heating or the number of kilowatt-hours to be used with purchased energy. When estimating the fuel to be used for heating it is well to present every step in the securing of the final figure, thereby giving the client all possible assistance in having this amount checked up by his consulting engineer. Frankness and conservatism in the long run are invaluable assets.

COMMERCIAL POLICY.

The public-service corporations are frequently considered by the masses to be monster soulless monopolies, greedy and heartless. The truth of the matter is that the commercial policies of some lighting companies are prompted by such a desire to be more than fair that things are done which would be more in keeping with a charitable institution. Let the corporation deal as though it were a private concern, giving nothing away for the sake of giving and allowing each customer to feel that the company has a personality. Give value for value received, and treat the electrical contractor as the grocer treats the plumber.

Department-store advertisements aim to increase public knowledge of merchandise for sale. The electric company should use advertising space for acquainting the public with the applicability of electricity to industrial uses. When a trust company places a man in charge of an estate comprising manufacturing industries and when that man, versed as he may be in banking, does not know that the electric company's energy is practical for driving anything larger than a sewing-machine, it is high time to institute a publicity campaign which will reach such persons. They know about fans, flatirons and percolators—the more unproductive devices connected to the electric lines. Advertise power and play for the biggest odds. A half page devoted to a cut of a large manufactory which has discontinued engines and is purchasing central-station energy, with a few pertinent facts relating thereto in large type, is sure to attract attention. Repetition of this will bring results, for, as previously stated, when the customer realizes that the lighting company is supplying energy as cheaply as the isolated plant usually makes it the campaign is half won.

One's relations with prospective customers should be practically the same as with existing ones, remembering that on becoming acquainted with them it is well to let them understand one's method of doing business. The central-station salesman is frequently misunderstood by the buyer who is accustomed to have quoted to him an upset price which is shaved down at the final deal. Since the representative of the public-service corporation has a fixed rate, and that only, he cannot do as others who would sell to this price-cutting purchasing agent, that is, quote a price sufficiently high to permit of reductions. Having only one price he will save time by giving his full and final proposition as such, with the definite assurance there is nothing better to follow.

A customer once secured usually requires little attention, but he must not be forgotten altogether, for the woods are full of all kinds of engine salesmen who are as enthusiastic for their service as central-station men are for theirs. It is conceivable that the customer may receive a sufficient number of calls from competing salesmen to start him brooding over real or imaginary grievances. An occasional pastoral call from the electric man enables imaginary grievances to be dissipated and real ones to be corrected. Remember that the best advertisement is a well-satisfied customer.

Too frequently the motor-service man feels disinclined to impose himself upon his prospective customer. He walks back and forth, up and down the street, past the customer's door, screwing his courage to the sticking point. This feeling is uncalled for; the majority of power salesmen have the right to claim the distinction of being the most highly trained experts in the selling business. The commodity which they handle almost invariably tends to better the condition of workmen and the quality of output. It is the last and most potent of the forces of nature to be turned to the use of man, and its adoption is increasing at a spectacular rate.

COMPARISON OF GAS AND ELECTRIC IRONS IN A NECKTIE FACTORY.

The Rochester Railway & Light Company supplies both gas and electricity in Rochester, N. Y., and has solicitors energetically pushing both services. The data on the comparative value of electric and gas irons for haberdashery

PERFORMANCE OF GAS AND ELECTRIC IRONS IN NECKTIE FACTORY.

Person.	GAS.		ELECTRIC.	
	Dozen.	Minutes.	Dozen.	Minutes.
S.	2	34	2	30
S.	1	16	1	14
F.	2	20	2	15
L. C.	3¾	60	4¾	60
A. E.	3	65	3	60
P.	2	33	2	25
D.	5	115	5	100
X.	4	70	5	70
A. R.	1	24	1	20
A. R.	½	13	½	10

work which it has compiled can therefore be accepted as coming from an unbiased authority. The electric irons are of the 6-lb., 250-watt type and the other irons are heated on small flat-top gas stoves. The performances of both are given in the accompanying table.

Electric irons have increased the output 15 per cent, and the manufacturer claims that very few ties are scorched, and that there is no shine left on the goods when these irons are used.

During one week there were ironed with two electric irons 266 dozen ties and with the gas irons 469 dozen. On this basis it will cost $13 a month to operate all the irons necessary for a factory output of this amount, and between $30 and $35 for the same output if gas irons of the type described above are used.

Wiring and Illumination

HEIGHT OF SUSPENSION OF METALLIC-FILAMENT LAMPS IN STREETS.

In a recent issue of *Electrotechnik und Maschinenbau* Dr. L. Block discussed the best design of a reflector for metallic-filament lamps suitable for street lighting and dealt with the choice of the height at which metallic-filament lamps in streets should be suspended. He shows why it is wrong to base such a rule on the distance between the lamps. He argues that the height should depend essentially on the candle-power of the lamps. He recommends the following approximate rule: The height h of the lamp should be $h = 3.5 + 0.1 \sqrt{C}$ when C is the mean horizontal candle-power of the lamp or the sum of the candle-powers of various lamps are connected together in one fitting and h is measured in meters. When h is measured in feet the formula becomes $h = 11.5 + 0.33 \sqrt{C}$.

ORNAMENTAL SCROLL-BRACKET LAMP-POST FOR NEW YORK.

The lighting of the public thoroughfares of New York presents a multiplicity of conditions comparable with those obtaining in small cities, for instance, in the outlying districts, and with cities of the first and second class in the business sections of the boroughs other than Manhattan, and yet possessing problems distinctly peculiar to itself in the congested streets and squares of Manhattan. The lighting of the main thoroughfares is individual, to the degree that not only are the locations of the posts fixed by actual survey in the field, but the lamp support itself is designed for particular locations. The make-up of the standard post varies for thoroughfares of different widths and different conformations, as, for instance, in a parked street, and is of different heights and projections to meet such conditions as are presented by the elevated-railway structure in the one case and by heavily treed avenues in the other case, due consideration always being given to the candle-power of the unit and to the distribution from the light source.

A newly designed lamp-post has been added to those already made part of the street-lighting equipment of the New York Edison Company. (See "Arc-Lamp Posts of New York," *Electrical World*, Dec. 8, 1910.) The post which is shown in Fig. 1 is being installed on Seventh Avenue, north and south of the Pennsylvania terminal, and in several other localities of similar character. The general plan for lighting avenues forming main arteries of travel provides for the installation of a post on diagonally opposite street corners, set on the house line of the intersecting street. By this means the post is placed approximately 15 ft. back from the apex of the corner, giving unrestricted access to the corner and insuring proper illumination where most essential at night. It also precludes the cutting off of light on the roadway on either side, owing to passing trolley cars or other vehicles. Such a condition occurs where but a single lamp is placed at the street intersection.

As previously pointed out in these columns, the design of the street-lighting fixture for public work in the city of New York must meet the approval of the Art Commission of New York, as well as that of the commissioner and chief engineer of the Department of Water Supply, Gas and Electricity. Obviously it must also possess such physical characteristics as to be applicable for both multiple and constant-current lamps. The many factors thus presented require careful consideration and are possible of solution alone from full-sized models. The detail of ornamentation, the growth of the ornamentation in elevation, and its incorporation in the lamp bracket without distortion in a form harmonious with a structure approximately 25 ft. high are worked out from plans of different modelers, their various individual interpretations forming the basis of the ultimate design. The component parts are the foundation, vertical member, enveloping castings and lamp support. These are a departure from the generally

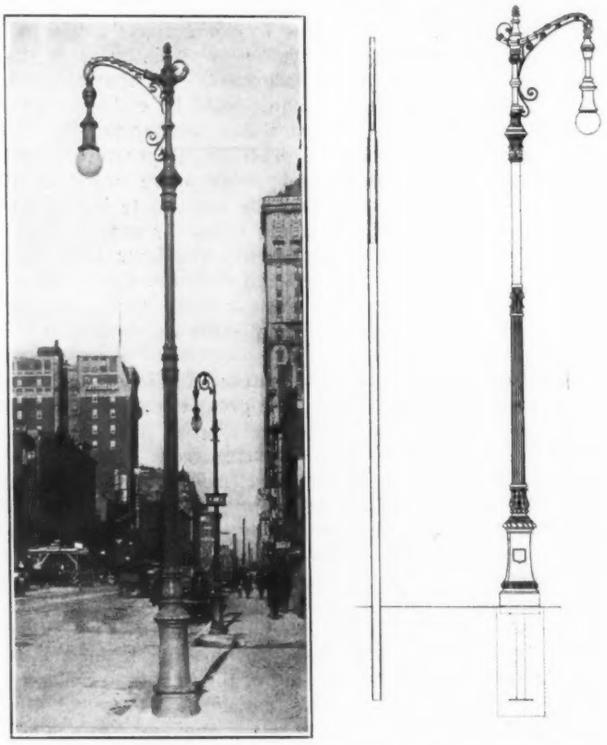


Fig. 1—New Ornamental Scroll Bracket Post in New York.

accepted practice incidental to iron lamp-post equipment, the bracket particularly being a distinct innovation from the lamp support generally used in this country.

The foundation of concrete is prepared in advance with a collapsible form, and when set has an opening just large enough to receive the tubular shaft. The shell-like castings that make up the ornamental post equipment are slipped over the top of the vertical steel member and interlock at points in the ornamentation, leaving no visible joint. The lamp support, in the form of a scroll bracket, is rigid in construction and as light in weight as possible, the desirable broad scroll effect being obtained by employing channel iron with the web turned edgewise. Its design makes it universal as to direction, as well as variable as to height between 17 ft. and 24 ft., both the horizontal and vertical features referred to being possible of accomplishment in the field without additional machine work.

Many advantages accrue in an ornamental post of this character over the all-cast-iron type, the most important being the simplicity of the sub-surface work and the

absence of detailed parts, thus making all sections interchangeable. Naturally every advantage was taken in the installation of these posts, costly under the most favorable conditions in New York City, and electric automobiles were used in their erection, resulting in many economies.

Fig. 2—Detail of Scroll Bracket.

The automobiles, one of which is shown in Fig. 3, are equipped with auxiliaries in the form of winches, derricks and electrically operated towers, supplied in each case by energy direct from the vehicle battery.

Electric trucks equipped in the way described have made possible the installation of some 2000 lamp-posts in Manhattan during the year just ended. The determination of

Fig. 3—Electric Truck Fitted with Erecting Derrick.

the department of Water Supply, Gas and Electricity to increase the street illumination has necessitated the replacement of hundreds of the older equipments, as well as the installation of new, and the rapidity with which this work was done is due to the use of the automobiles.

Letters to the Editor

Registering Maximum Demand.

To the Editor of Electrical World:

SIR:—Referring to the very interesting communication on "Registering Maximum Demand," by Mr. Cecil W. Brown, which appears in your issue of Dec. 2, page 1315, may I correct an erroneous impression which I fear will be given by Mr. Brown's letter?

I agree with all that Mr. Brown says about the crying need for an inexpensive instrument or attachment for registering the integrated maximum demand. He is right also in recognizing Mr. Charles H. Merz, Newcastle-Upon-Tyne, England, as the inventor of the basic patent, No. 722,030, which controls the manufacture and sale of such devices. But I fear Mr. Brown's failure to say that the American owner has only recently acquired the Merz patent may give rise to the idea that the present owner, the Minerallac Electric Company, of Chicago, is the object of his censure.

Mr. Brown says that his discovery of the existence of the Merz patent impelled him to drop any idea of patenting his own device, but adds that he does "not intend abandoning the subject until some one explains why it is that a patent can be issued in this country and smothered for eight years, while during this time central stations either pay a sum running into three figures for kilowatt maximum-demand meters or else adopt methods for measuring energy which no reputable concern should countenance for a moment and which every customer should rightly condemn. It is farcical in the extreme to see instruments of precision relegated to the background or else coupled with an arbitrary standard (!) due to our archaic patent laws, business regulations or what not. The American owner of Patent No. 722,030 states that these maximum-demand attachments can be expected to be on the market in the next few months, but where have they been for the past eight years?"

The fact is that the present American owners of the Merz patent have felt as strongly as Mr. Brown the need of just such an instrument as he describes. But, like him, they were compelled to recognize the Merz patent as standing in the way of anyone wishing to market such an instrument in this country, and finally entered into negotiations for the outright purchase of that patent, which purchase was consummated only a few months ago. Since that time the development of this new type of instrument for small consumers has been pushed with the utmost vigor, and the first lot of instruments to fill trial orders on hand is now about ready for shipment. The present American owners cannot therefore be rightly accused of smothering the Merz patent for eight years.

It is the purpose to furnish an instrument which, as Mr. Brown suggests, will be on a par with the watt-hour meters now employed to measure the consumption factor under a differential rate. I fully believe that these new forms of instruments as manufactured under the Merz patent, which are totally different in details of construction and known under their several forms by the trade names of "Maxicator" and "Maxometer," will adequately solve the problem of determining the maximum demand for small consumers.

The problem to be solved is very different in the case of a small consumer from what it was in the case of a large power customer. The average yearly bill from all residential customers in a city of moderate or large size is only $25 per year. On the other hand, the yearly bill for a 50-hp motor fully loaded for nine hours per day and at average rates is $2,000 per year. An accurate maximum-demand instrument, costing, say, $100, would, therefore, represent 1 cent per dollar of income if run for a period

of five years only, and correspondingly less for a longer period.

Furthermore, the high-rate portion of the bill for this 50-hp motor, or the portion directly affected by the maximum demand, would with most power rates now in effect average $1,200 per year. An error of 10 per cent, which is a very frequent result with many of the old systems of determining or arbitrarily fixing maximum demand, would be $120, or more than enough to pay for a good instrument in one year. In other words, the purchase price of a high-grade maximum-demand instrument such as is already on the market is a very small matter in the case of commercial or industrial power users, but the purchase of a maximum-demand instrument for residential customers is quite another matter. I believe that the new "Maxicator" and "Maxometer" built under the Merz patent are the answer to Mr. Brown's problem.

Chicago. CHESTER I. HALL.

To the Editor of Electrical World:

SIR:—The communication from Mr. Cecil W. Brown in your issue of December 2, 1911, referring to your editorial of Nov. 4 deserves hearty commendation. Truly there is a real need for better methods of measuring the retail value of electricity.

The matter of a system of rates of charge for electricity for residence purposes is in a rather chaotic condition. If there is indeed a simple device that will transform the ordinary residence watt-hour meter into a maximum-demand watt-hour meter a very great advance will be made by the adoption of such an instrument. The use of the method of estimating "active rooms" and of basing the charge, to some extent at least, upon the ratio of maximum demand, as indicated by "active rooms," to average demand, is certainly an effort to move in the right direction. However, as pointed out in Mr. Brown's communication, the method is at best a rather crude one and should be regarded as only an effort to approach a satisfactory solution instead of as a satisfactory solution in itself.

The influence that a customer's maximum demand should have on the price to be charged for the service is frequently somewhat misunderstood. I take it that the main advantage of the "active-room" method is not its maximum demand feature, but that it really puts electricity for flatirons, toasters, sewing-machine motors, etc., on a lower rate than the ordinary quantity of electricity used for lighting must carry. Undoubtedly this result is very much to be desired, and therefore the "active-room" method seems at least better than what went before. The use of a maximum-demand meter, while preferable, would not wholly cover some of the advantages of the "active-room" method. The truth is that a single customer's maximum demand has very little bearing on the cost to supply him. It is the character of the customer's service (lighting, for instance) which may not only bring his maximum demand always at the same time of day, but brings his maximum at the same time of day as that of many other customers, and therefore makes a peak load for the station, that makes maximum demand so vital an item.

Even if the meter reported at the end of the month the total amount of electricity used during each hour or group of hours it would not give the desired separation into lighting and auxiliary uses. In deciding upon a fair charge for electric energy it is proper to consider two factors: First, the actual cost to the seller of supplying that particular grade of service; second, the value of that service to the consumer and the price the consumer can afford to pay. For example, the seller at a given time of day can manufacture a kilowatt-hour for electric heating just as cheaply as it can manufacture a kilowatt-hour for incandescent lighting. Obviously, however, the consumer can afford to pay a much better price per kilowatt-hour for the latter service than for the former one. It is perfectly legitimate for the seller to make a distinction based upon the value of the service to the consumer, even though the cost of manufacturing be the same. By making such distinctions the rates as a whole may be kept lower and the service be made more satisfactory than without distinctions.

Electricity used for incandescent lighting really costs the manufacturer a maximum and at the same time the consumer gets the most service from a kilowatt-hour. It is quite logical therefore to charge a higher rate for lighting and a lower rate for the various auxiliary uses. Precisely this result is supposed to be had from the "active-room" system. Even the most detailed information covering time of use, maximum demand at various times of day, etc., would not lead to such a separation of charges. At the same time it must be conceded that, as pointed out by Mr. Brown, the "active-room" assumptions are open to question.

Would it not be really better to assume that the *shape* of the load curve and the customer's load factor are about the same for all residences? Is not this, in fact, pretty close to the truth? If so, by combining a "connection charge" with a block-system kilowatt-hour charge one can reach a reasonably satisfactory conclusion. If the character of use of electricity is about the same for all residences it would perhaps not be wholly unscientific to figure out a typical daily load curve for residences and to base the charges upon the cost of supplying the service, assuming that the shape of the daily load curve is the same for all residences. Such an assumption, of course, would mean that no attention would be given to determining maximum and average demands for any particular residence, at least until an instrument comes into use that may make such determinations accurately. It is necessary, however, that the charge shall in some manner take account of service rendered by the seller which does not appear on the customer's meter; that is to say, the general cost of supplying service to the residence, whether the particular residence ever consumes any electricity or not. The seller must run supply wires to the residence, must furnish and install a meter, must supply a transformer and keep its core magnetized twenty-four hours per day, must see that the meter is read regularly and must maintain a separate account on its books for each individual consumer. It seems to the writer that the best method of taking care of such costs that has yet been suggested is to bill them directly to the customer in the form of a "connection charge," to be paid whether any energy be consumed or not.

I do not mean that the total cost of being ready to deliver service should be assessed in this manner, but only that portion of the cost which is necessitated solely by the individual customer and which comes from the furnishing of apparatus or service, no part of which can possibly be used by any other customer. Therefore let the connection charge cover only the cost of the customer's service and not the cost of any part of plant, transmission or distribution system that is used by customers generally, all such expenses being taken care of in the kilowatt-hour rate. The connection charge, therefore, is not at all proportional to maximum demand and is not to be confused with a "readiness-to-serve" charge. The latter, of course, is based on maximum demand, but the connection charge is simply such monthly charge as will reimburse the seller for the cost of making and maintaining one customer's connection, assuming that said connection be never used.

It is true that the public does not yet take kindly to the idea of a connection charge. The public will accept either a minimum monthly charge or a double rate based on "active rooms," or both, more readily than it will accept the notion of a connection charge. Nevertheless in the writer's opinion the connection charge is really best for the public and best for the selling companies. If this opinion be correct it would seem that effort should be made to overcome public prejudice.

New York. GEO. L. HOXIE.

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Standardizing Machines.—R. POHL.—A paper read before the Yorkshire section of the (British) Institution of Electrical Engineers. The author urges the desirability of immediate revision of the British standard specification for electrical machinery, which he believes might have a beneficial effect on the British electrical industry. He discusses various features in the existing standards and suggests alterations. The most important of these deal with the method of rating, the wearing depth of commutators, permissible temperature rise, the method of measuring the temperature rise, standard frequencies, outputs and speeds. The author deals at considerable length with the permissible temperature rise. He points out that the highest temperature of the atmosphere for which standard machines are intended to be suitable is given in the British standards as 25 deg. C. (77 deg. Fahr.), whereas the German rules are based on an air temperature of 35 deg. C. as a maximum. He urges that the same figure—that is, 35 deg. C.—be adopted as the basis for the British standards, chiefly in order to meet the requirements of the export trade. Next, as to the method of measuring the temperature rise in the case of field coils, average British practice, as distinguished from the "British standards," permits a rise of from 70 deg. Fahr. to 75 deg. Fahr., or about 40 deg. C., as measured by a thermometer on the surface of any stationary or moving coils. The measure of surface temperature, however, gives no indication of the inside temperature. In Great Britain the surface temperature is measured by a thermometer, but in Germany the temperature rise is determined by a measurement of the resistance. This explains the difference in the design of the field coils of German and British machines. The former employ to a very large extent subdivided and ventilated coils, which are very rarely met with in England. The measurement of the temperature of the field coils by the resistance method, while recommended by the British engineering standards committee, is practically not used at all in British practice. It is cumbersome and complicated and has the inherent defect that it furnishes, after all, only the mean temperature of the whole field circuit and takes no account of the discrepancies in the temperature of individual coils. The author prefers the use of a thermometer inserted within the field coil. It is only necessary to this end to wind into the field coil at a point where the maximum temperature may be expected a separator of wood or other insulating material enabling the subsequent insertion of a thermometer. Fig. 1 indicates the arrangement of the separating distance piece for the

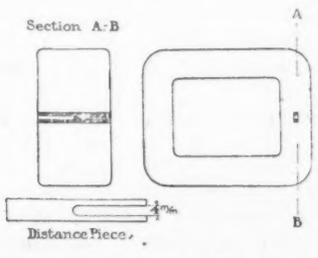


Fig. 1—Separating Distance Piece for Field Coils.

field coils. In a series of tests carried out on coils as shown in Fig. 1 the internal thermometer registered in all cases a temperature rise between 12 per cent and 20 per cent higher than was ascertained by the resistance method. The author thinks there is no justification for retaining the resistance method for distributing windings, the simple thermometer test being preferable from all points of view. The present rules provide for a six-hour test for all rotating machines irrespective of size. The author would prefer to determine the length of the test according to the rate of temperature rise at its end. He thinks that one gets near enough the final temperature rise in modern rotating machines if the

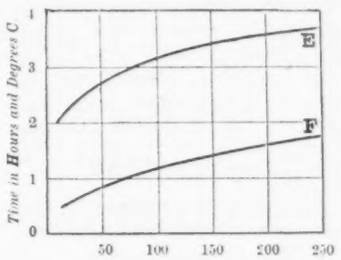


Fig. 2—Heating Curves.

temperature at the end of the run is still rising at the rate of 1 deg. C. during the half hour. Fig. 2 gives the time required for well-ventilated machines to approach their final temperature. Curve E gives the hours run for a temperature rise of 1 deg. C. in the last half hour. Curve F gives the difference between final temperature and temperature after run for 1 deg. C. rise in last half hour. (Final temperature rise, 30 deg. C.) It appears that under the suggested rule a 10-hp protected-type motor need be tested for only two hours, a 50-hp protected-type motor for two and three-quarter hours, and the error introduced by reducing the testing period to these low figures is less than 1 deg. C. in both cases. Summarizing, he suggests the following rule: The duration of the full-load test shall be such that the temperature rise shall not increase by more than 2 per cent during the last half hour of the run. In order to ascertain this, a thermometer fixed to a suitable stationary part of the machine shall be employed. As the duration of the test of very small machines would obviously become exceedingly short, it might perhaps be advisable to fix a minimum length of test of two hours. This must be such as to insure that in the interior of field coils the actual temperature of 125 deg. C. and in distributed windings 110 deg. C. is not exceeded. The highest rise must, in consequence, not exceed 125 — 35 = 90 and 110 — 35 = 75 deg. C. respectively. For distributed windings, such as those of direct-current armatures, alternating-current stator and rotor coils, the temperature of which must be measured by thermometer on the surface, an allowance must be made for the temperature drop in the outer insulation and in the interior of the coil. The sum of these is not likely to exceed 20 deg. C. In addition one should allow 5 deg. C. to meet the discrepancy due to reducing the duration of the test, or a total of 25 deg. C., leaving a rise of 50 deg. C. In the case of field coils for direct-current machines and alternators, if measured by internal thermometer, the margin to be allowed consists of 10 deg. C. possible error due to the thermometer not being placed at the point of highest temperature, and 5 deg. C. on account of the reduced length of run, leaving a rise of 75 deg. C. This is a much safer specification than the one of 40 deg. C. rise measured at the surface, and also safer than the present recommendation of 60 deg. C. measured by the resistance method. The development of such well-known materials as asbestos and enamel-covered wires, which are bound to become of great importance, might well be encouraged by allowing definite higher temperature rise where they are employed. Single-layer windings of heavy copper strip, wound on

edge, as largely employed for commutating poles, and sometimes for alternator coils, would also be quite safe if one allowed a temperature rise of 75 deg. C. as measured by a thermometer on the surface, seeing that such coils possess an almost uniform temperature throughout.—Lond. *Electrician*, Dec. 8.

Neutral Line of Brushes.—L. Verain.—In practice the correct position of the brushes along the neutral line is important, and the author describes various methods for determining the neutral line, especially two which are quite accurate and depend on the determination of that position of the brushes for which the coefficient of mutual induction between pole system and armature is zero.—*La Lumière Elec.*, Dec. 2.

Calculation of Shunt Field Coils.—F. T. Chapman.—The author gives a method of calculating the winding of the field coils when it is necessary to make use of two different sizes of wire in each coil.—Lond. *Electrician*, Dec. 15.

Lamps and Lighting.

Condensers and Metallic-Filament Lamps.—An article on the system of A. W. Ashton for the use of condensers on alternating-current circuits to supply energy to metallic-filament lamps of any voltage less than the supply voltage. For dwelling houses where less than, say, twenty-five lamps are installed Ashton claims that the use of condensers compares favorably as regards initial and running costs with both 200-volt lamps and low-voltage lamps used in conjunction with an auto-transformer. There are two methods of applying condensers. The first is the parallel system, in which all the circuits are in parallel and in which each circuit consists of a lamp (or group of lamps controlled by a single switch) and a condenser in series. The other arrangement is the series system. In this several lamps of low voltage (say, 8, 12 or 16 volts) are connected in series with each other and a condenser, the lamps being controlled by short-circuiting switches. The size and cost of the condenser are directly proportional to the lamp current and inversely proportional to the frequency and voltage of the supply circuit. The cost of the condenser can generally be saved during the life of the first lamp. In the series system all of the lamps are connected in series and in circuit with the condenser across the mains. Switches are fixed in parallel with the lamps so that when a switch is closed the corresponding lamp is short-circuited. Provided that the sum of the voltages of the lamps in use at the same moment does not exceed about 40 per cent of the supply voltage each lamp gets within 3 per cent of its rated current independent of the number of lamps switched on. One of the most interesting features of the series system is that the lamps need not be all of the same candle-power, and for increased candle-powers higher voltage lamps requiring the same current can be used. A special application of this is the connection of a 25-watt and a 5-watt lamp to the same condenser, using a two-way switch, thus allowing a low-candle-power lamp to be used in nurseries and in sick-rooms for night light. Again, with three-lamp pendants or electroliers the two lamps on one switch can be run in series and the third lamp, used with a condenser, can be of the same candle-power; or the three lamps may be for 25 volts pressure and run on the series system with short-circuiting switches. The system is particularly suitable for wiring groups of houses or flats where energy is metered to the owner of the flats and occupiers have an unlimited supply at an inclusive charge. The condenser in such cases acts as a current-limiting device, since the current is mainly determined by the condenser used, and any attempt to increase the load by installing lamps of larger candle-power causes a reduction in the amount of light. The condenser also prevents the overshooting effect when metallic-filament lamps are switched on. Moreover, the leading current taken by the condenser is advantageous to the central station.—Lond. *Electrician*, Dec. 8.

Graphite Filament.—A note on a recent British patent (No. 13,021, Dec. 7, 1911) of the British Thomson-Houston Company (General Electric Company of this country) for a process for producing pure graphite conductors, especially for use in incandescent-lamp filaments having a density approximating 2.26. These are squirted or otherwise shaped from a mixture of finely divided pure graphite with a binder, which is subsequently carbonized or graphitized. A suitable binder consists of coal-tar pitch soluble in benzol, which becomes sufficiently liquid to flow at about 180 deg. C. —Lond. *Elec. Eng'ing*, Dec. 14.

Arc-Lamp Electrodes.—A note on a recent British patent (No. 14,729, Dec. 7, 1911) of P. and E. Conradty. To secure regular and slow burning in impregnated arc-lamp electrodes the active material is arranged in spiral grooves formed on the outside of the electrode, so that the arc follows the spirals and is carried gradually round.—Lond. *Elec. Eng'ing*, Dec. 14.

Self-Induction of Incandescent Lamps.—M. Höchstädter.—An English translation of his German paper abstracted some time ago in the *Digest* on a determination of the self-induction of carbon-filament incandescent lamps. —Lond. *Electrician*, Dec. 15.

Generation, Transmission and Distribution.

Transmission System.—A. Feldsmann.—The conclusion of his illustrated description of the high-tension transmission system from the bituminous coal mine Rheinprüssen near Homberg. Details are given of the 20,000-volt transmission line and of the results obtained with iron poles and also of the overhead telephone cable used in connection with the transmission system.—*Elek. Zeit.*, Dec. 14.

Centrifugal Pump Motors.—J. S. Leese.—An article on the control of centrifugal pump motors. Direct-current shunt motors may be used controlled either by shunt-field variation or by a resistor in the armature circuit, the latter system being less expensive unless the speed variation is small, not exceeding 20 per cent. Induction motors may also be used controlled by varying the frequency. Some notes on starting are added.—Lond. *Elec. Review*, Dec. 15.

French Water-Powers.—H. Bresson.—An article giving maps and details of the available water-powers of the Rhone River district.—*La Revue Elec.*, Dec. 8.

Installations, Systems and Appliances.

Brazil.—C. E. Best and H. L. Parrott.—A long article discussing the present conditions of Brazil and the possibilities for future commercial relations with Great Britain. The authors deal with the climate, topography and watercourses, mineral resources, the attitude of Britishers in Brazil and the journey to that country, and give a description of the Rio de Janeiro Tramway, Light & Power Company.—Lond. *Elec. Review*, Nov. 10, 24 and Dec. 15.

Suction Gas and Insulation Troubles.—Leonard Harding.—An article on occasional insulation troubles on generators driven by gas engines supplied with suction gas. The general experience seems to be that conducting surfaces are formed at the back of the commutator, causing "grounding," but very seldom complete breakdown. These troubles are generally experienced when there are comparatively large quantities of sulphuretted hydrogen in the engine-room and gas-plant house. These gases also affect the switchboard and are injurious to the health of workingmen. It is suggested that insertion of a layer of ferric oxide or lime inside of the existing gas scrubber would prove a remedy.—Lond. *Elec. Review*, Dec. 15.

Tariff.—J. A. Schouten.—The first part of a paper illustrated by diagrams on the theory of tariffs for electrical energy. Various characteristic curves giving the mean receipts per kw-hour as a function of the number of hours of consumption per year are given. The reasons for changes of these curves in time are discussed. The paper is to be concluded.—*Elek. Zeit.*, Dec. 14.

Wires, Wiring and Conduits.

Insulators.—W. WEICKER.—An illustrated article on various new types of suspension insulators and the results obtained with them in practice. The article is to be concluded.—*Elek. Zeit.*, Dec. 14.

Electrophysics and Magnetism.

Peltier Emf.—A. E. CASWELL.—An account of a redetermination of the Peltier emf for a number of combinations of metals. Use was made of two new methods, both of which depend upon maintaining both junctions of the given couple at the same temperature by supplying heat at the junction where cooling is taking place. The Peltier emf is determined by measuring the ratio of the heat so supplied to the quantity of electricity sent across the junction. The first or "separate heating-coil" method consists essentially in placing the two junctions of the couple in two separate calorimeters containing equal quantities of a suitable liquid. Each is provided with an electric heating coil of known resistance, by means of which sufficient heat is supplied to the liquid where cooling is taking place to maintain it at the same temperature as that where heat is evolved, the equality of temperature being shown by a differential thermometer. The second or "shunt-current" method differs from the first method in that compensation is accomplished by sending more current through one of the junctions than through the other, the difference in the Joule heating effect being equal and opposite to that arising out of the Peltier effect. The methods were used for the combinations copper-bismuth, copper-silver, copper-aluminum, copper-platinum and copper-nickel. The results are as follows:

Metal Against Copper.	Peltier Emf Expressed in Millivolts.	Temperature Deg. C.
Copper	....	....
Silver	0.03	18
Aluminum	0.70	16
Platinum	0.85	17
Nickel	6.00	22
Bismuth	16.10	18

Finally it is shown that the measurements are in fairly good agreement with Thomson's theorem stating that the Peltier emf equals the absolute temperature multiplied by the temperature coefficient of the thermo emf.—*Phys. Review*, November.

Ionizing Energy of Electrons.—EDWIN S. BISHOP.—A long illustrated account of an absolute determination of the minimum ionizing energy of an electron and the application of the theory of ionization by collision to mixtures of gases. The theory of ionization by collision is verified for pressures as high as 40 cm. The minimum ionizing voltage for any gas is constant, being independent of the gas pressure and field strength so long as the latter is sufficiently high to produce new ions by collision. These ionizing voltages were here found to be 9.66, 6.21 and 10.21 volts, for hydrogen, carbon dioxide and air respectively. The minimum ionizing field strength is directly proportional to the gas pressure for pressures at least above 1 cm.—*Phys. Review*, November.

Electrostatic Fields.—V. KARAPETOFF.—A paper giving general formulas for the calculation of electrostatic fields and illustrating them by practical examples; for instance, the caculation of a cable capacity and of the safety factor of overhead wires necessary to prevent corona.—*La Lumière Elec.*, Dec. 2.

Electrochemistry and Batteries.

Primary Battery.—W. R. COOPER.—Some notes presented before the Faraday Society on a new form of the Benkoe cell. The characteristic feature of this cell is that the carbon is very porous, so that the electrolyte (sodium bichromate, not the potassium salt, which might crystallize) circulates through the carbon walls and keeps the carbon depolarized. In the original type this circulation is insured by introducing the electrolyte under hydrostatic pressure. The carbon forms a flattened cylinder open above and below; it is provided with a lead ring at the top and a lead bottom, and a lead shell is soldered to the lead, so that there is an outer, narrow chamber between the lead and the outer carbon wall and an inner, wider chamber in which the zinc is placed. These cells give very strong steady currents. A cell weighing 10 lb. (without electrolyte), 9 in. by 6 in. by 1.75 in., yields 25 amp at 1.5 volts (first 2 volts) with a circulation of about 0.5 liter of electrolyte per hour. These batteries are very convenient for laboratory work and small house installations. The cost of the electrolyte is the chief item. The new "diffusion cell" requires neither an electrolytic cistern nor a circulation system, and is self-contained. When filling the cell strong electrolyte (acid and bichromate), having a density of 1.3, is run into the outer chamber, and water at a density of 1 into the inner. The liquids slowly diffuse through the carbon into one another, and as long as a difference of density prevails in the two compartments the cell will depolarize itself and "give a good current." A 5-lb. cell gave a current of 0.25 amp (finally 0.20 amp) for eight hours on four consecutive days, after which the current fell off rapidly. A 3-lb. cell would keep a small lamp lighted for eight hours for two days. Several types of portable hand-lamps for motor-cars and for miners were exhibited.—Lond. *Eng'ing*, Dec. 15.

Units, Measurements and Instruments.

Errors of Electricity Meters.—KARL SCHMIEDEL.—An article on the errors of electricity meters with rotating armature (alternating-current induction meters and direct-current meters). After a brief discussion of the fundamental theory of the subject the author gives results of measurements concerning the different sources of error. He first discusses the torque due to friction and shows that an increase of the armature weight increases the friction by a value that is independent of the speed. Therefore at low speeds an increase of the weight of the armature has a relatively greater effect than at high speeds. The author then discusses the torque due to friction compensation, the torque due to the damping device, the variation of the phase difference between current and magnetic flux, and the fluctuations of the magnetic flux of the circuit per unit of current. Finally the results are summed up in the form of formulas, tables and diagrams.—*Elek. u. Masch.* (Vienna), Nov. 19 and 26.

Book Review.

CENTRIFUGAL PUMPS. By Louis C. Loewenstein, E. E., Ph. D., and Clarence P. Crissey, M. E., New York: D. Van Nostrand Company. 424 pages, 320 illus., 8 folding plates. Price, $4.50.

An engineering textbook on the design, construction and operation of centrifugal pumps, carefully prepared for engineering students and pump engineers. The seven chapters of the book are devoted to the following topics: Theory of centrifugal pumps, consumption of power and efficiency, regulation and classification, calculation of impeller and guide vanes, design of important pump parts, types of centrifugal pumps and testing of centrifugal pumps. The descriptions in the text are clear and the illustrations are good. The first 200 pages are occupied with mathematical theory, but the mathematics are those of the engineer. The book will be of value to the advanced student of hydraulics, to designers and testers of pumps, and to the engineer who is interested in pump development.

New Apparatus and Appliances

GAS ENGINES WITH SELF-CONTAINED MAGNETOS FOR IGNITION PURPOSES.

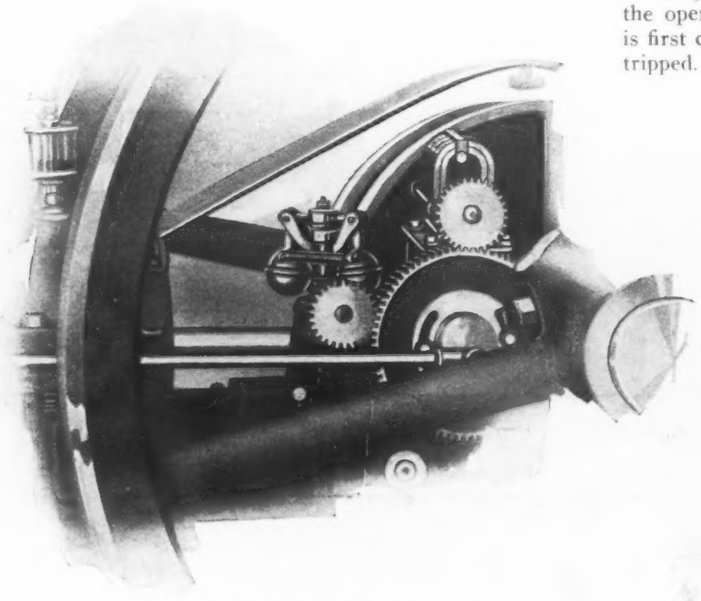
The Foos Gas Engine Company, of Springfield, Ohio, has abolished the use of batteries with its standard-type engines and hereafter will use magnetos for running as well as for starting, placing full reliance on its new generator and the wipe-spark igniter. The step is of interest since this is the first American engine to embody a "built-in" magneto in its design, rendering the gas engine a complete unit.

Separately driven magnetos are at best only mechanical makeshifts, it is declared, although the source of ignition energy should be as substantial and durable as the engine itself. Batteries have always been excepted in engine guarantees, since they require frequent renewal and cause considerable expense and often costly delays. The spark is sometimes affected by the temperature of the engine-room, the age of the battery and other conditions. On the other hand, it has heretofore been difficult to get a spark from the ordinary magneto while starting a large engine by hand, and make-and-break igniters were not thoroughly satisfactory on account of the pitting of their electrodes.

The Foos wipe-spark igniter, although theoretically belonging to the widely adopted class of make-and-break igniters, has many exclusive features in mechanical construction and operation. For the customary hammer action there is substituted here frictional contact through the wiping action of a revolving blade, the surfaces being wiped clean during each impulse.

A low-voltage, slow-speed alternating-current magneto is the source of energy in the new form of ignition. Battery, coils, timers, switches and much of the wiring are thus eliminated, and the mechanical equipment is further simplified by the absence of commutator, brushes or field coils. Friction wheels and speed governors are also avoided, the magneto being positively driven at engine speed through gears directly from the crank-shaft. The magneto employed is unusual on account of the size and number of its magnets, which are of tungsten steel. Each of the six magnets measures 5/16 in. by 1½ in. and is securely bolted to the pole pieces by special screws accurately ground to fit without tin shims or other makeshifts. The armature is laminated, and the armature housing is particularly strong and rigid, being prevented from distorting or changing its shape in any way. In addition to impregnation with an insulating compound, unusual precaution is taken to make the armature-coils oil-proof and mixture-proof. The current collectors bear on smooth, polished steel surfaces.

Since this magnet produces an alternating current, with two peaks for each revolution of the armature, the relative position of these peaks can be fixed and synchronized by driving the magneto positively and setting the armature in proper relation to the engine, thus making its developed emf most effective for ignition purposes.

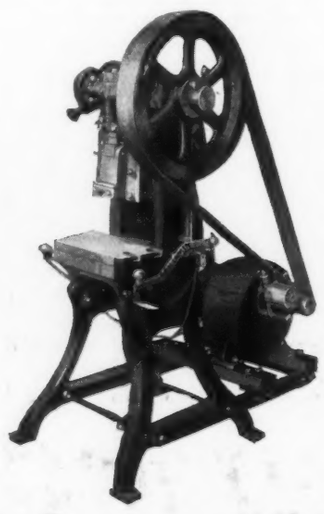


Gas Engine with Self-Contained Magneto.

SAFETY DEVICE FOR STAMPING PRESSES.

The safety device for stamping presses shown herewith is intended to protect the hands of the operator of stamping presses by necessitating the removal of both hands from the point of danger to trip the press before the ram starts in its downward direction. The release of either hand permits the trip to return to its normal position, thus making it impossible for the press to repeat unless both hands are kept on the levers until the repeat operation is begun, in which event the operator would not have time to get his hands back into danger before the operation is completed. The device consists of an operating lever normally inoperative, although free to move downward. This lever is made operative by the action of a retaining electro-magnet through a circuit closer located on the opposite side of the press. Consequently the press cannot be tripped by the operating lever unless the circuit through the magnet is first closed and kept closed until after the press has been tripped. The confidence thus created materially increases the number of operations actually performed, with a corresponding increase in the amount of work done.

The device, which is made by the Benjamin Electric Manufacturing Company, of Chicago, can be adapted to all the standard presses. No drilling of holes is necessary, and the magnets are wound for 110 volts.



Stamping Press Equipped with Safety Device.

PORCELAIN BUSHINGS.

A new type of porcelain clamp bushing insulator, shown herewith, is being placed on the market by the American Bushing Company, of Chicago, and the claim is made that

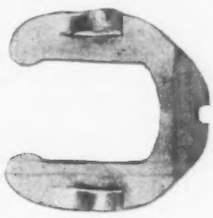


Fig. 1—Vitrified Porcelain Bushing. Fig. 2—Steel Clamp.

it is simpler, superior to and cheaper than anything on the market. It consists of a vitrified porcelain bushing, on the neck of which are several diametrically opposite slots or indentations, as shown in Fig. 1, and a steel clamp (Fig. 2) with spring arms which when placed in position in any of the slots (according to the thickness of the metal or other substance) at once forms an absolutely tight fastening

Fig. 3—Inside View of Bushing and Box.

which locks itself automatically. Fig. 3 shows the reverse or inside of the bushing and box. The bushings are made in seven standard sizes, but, of course, can be made any special length and diameter to suit the occasion. The same clamping device is also used in a new outlet box and sign socket which the above firm manufactures.

RENEWABLE CARTRIDGE FUSE.

Since the advent of cartridge-inclosed fuses a number of years ago there have been a number of attempts to construct a product of this nature which would possess the necessary electrical characteristics and at the same time be renewable at a very low cost. This work is highly commendable since the continual replacement of a complete cartridge fuse, especially in places where fuses are blown frequently, materially increases the maintenance expense of the equipment.

The Economy Fuse & Manufacturing Company, Pittsburgh, Pa., appreciating that the electrical performance of a device of this kind was of primary importance, conducted extensive laboratory experiments with a view to determining the physical properties of the elements involved and has recently placed on the market a renewable cartridge fuse.

Fig. 1—Renewable Cartridge Fuse.

The mechanical construction of the fuse is shown in Fig. 1 and involves features not common to previous products. One of the primary features, aside from the ease of renewing without making any soldered joints, is the fact that the active fuse element is brought into direct and positive contact with the copper blades at the end, the copper blades being held parallel and in proper position at

Fig. 2—Fuse Element.

all times by a very simple and unique construction. The shell is constructed of gray horn fiber.

As the electrical characteristics of a product of this nature are of primary importance, the company has paid particular attention to the development of a proper fuse element (Fig. 2), which would not only conform to the ratings of the National Board of Fire Underwriters, but which would not burn up or explode the shell under every-day service conditions.

The fuse is offered to the trade under a manufacturer's guarantee that it will perform in accordance with the Underwriters' ratings.

BOILER WATER-LEVEL ALARM.

The diagram accompanying shows a float-alarm for giving a warning when the water level in the boiler reaches its predetermined high or low load. Taps from the top and bottom of the water column are led to the welded-steel box shown. This box contains the float diagrammed in dotted lines, which is pivoted and connected to the pointer at the right. The dial and pointer thus give an auxiliary indication of the height of the water level, and the pointer scale is arranged with two adjustable contacts corresponding to the desired high and low water levels. Should the water fall below the predetermined level, the alarm-bell circuit is automatically closed. Such an alarm device will simplify considerably the attention required by the boiler, allowing

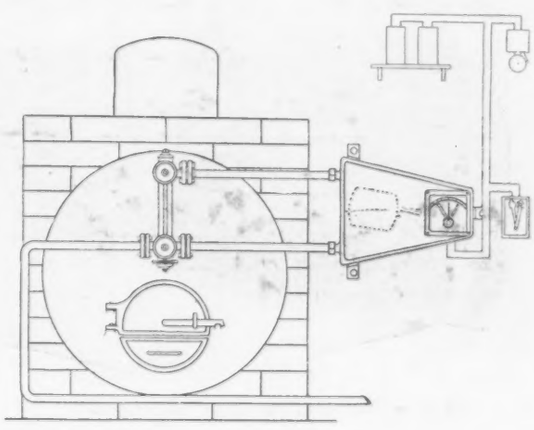


Diagram Showing Boiler Water-Level Alarm.

the fireman an opportunity to devote his time to other matters about the plant, giving only an occasional glance at the water-level indicator. The device illustrated is manufactured by Otto Rennert & Company, of Munich, Germany.

ELECTRIC IRON WITH AUTOMATIC HEAT REGULATOR.

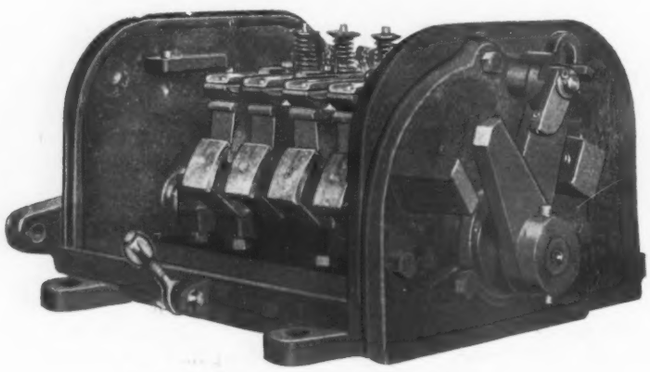
The accompanying illustration shows the "A-best-o" iron manufactured by the Dover Manufacturing Company, Canal Dover, Ohio, the important feature of which is the automatic cut-out to prevent the unit from becoming overheated. The energy consumed is regulated by the thumbscrew shown at the right, which can be set for any temperature from 200 deg. Fahr. to 600 deg. Fahr. The latter is the maximum temperature to which the iron can be heated and is suitable for heavy and damp ironing, whereas by

Electric Iron with Automatic Heat Regulator.

means of the automatic regulation the iron can be adapted for all classes of work. The heating unit can be easily replaced and is designed so as to distribute the heat over the ironing surface. The iron weighs alone 6½ lb. and is accompanied by 7 ft. of attachable cord. Packed with the stand it weighs 8½ lb. The manufacturer claims the following advantages: The elimination of attachment plugs, preventing the wearing out of contacts, sockets and switches; the possibility of allowing the iron to stand for any length of time without any danger of damage, and a saving of from 30 to 40 per cent in energy consumption, due to the automatic heat-control feature.

SAFETY-LIMIT STOP FOR ELECTRIC CRANES.

In electric hoist or crane service a limit switch to prevent overtravel of the hoist block is necessary to insure against serious accidents. The ordinary limit switch which merely opens the motor circuit has the disadvantages that



Safety-Limit Stop for Electric Cranes.

the stopping point varies considerably, and if the limit is set low enough to prevent dangerous overtravel when the hook is light and coming up at high speed, a loaded hook at slow speed will stop below the desired point. An adjustment that suits one condition is thus not satisfactory for all.

The Cutler-Hammer Manufacturing Company, of Milwaukee, has brought out the Palmer safety-limit stop shown in the accompanying illustration. This limit switch will, it is stated, bring the block to rest within 2 in. of any given point, regardless of load or speed. The trip rope used with this device is independent of the hoisting ropes, so that replacing the latter does not require adjustment of the switch, as with other limit stops. Tripping the switch not only opens the motor circuit as with other types, but establishes a dynamic braking action by connecting the series field across the armature, the motor thus being brought to a stop promptly. This limit stop is made in capacities up to 25 hp, 110 volts, and up to 50 hp, 220 or 550 volts.

ELECTRICALLY OPERATED HOSPITAL SIGNAL SYSTEMS.

The increasing application of electricity to hospital service has led the Holtzer-Cabot Electric Company, of Brookline, Mass., to design a number of signal systems to facilitate communication between the bedside of the patient and nurses', superintendents' and doctors' quarters. Special attention has been given to the questions of accuracy, speed of transmission, flexibility of control and checking of calls, which are of so much importance in handling critical cases scattered over wide areas. The apparatus covers nurses' annunciator systems, nurses' lamp systems, doctors' call systems and emergency calls. Among the new features brought out are an arrangement by which the patient's buzzer call sounds only so long as the bedside button is pressed, while the drop or lamp signal in the annunciator remains set until the nurse answering the call operates a resetting button at the side of the patient; provision of resetting semaphore and signal lighting targets at patients' rooms; lighting of monitor lamps on more than one floor when a single nurse handles more than two tiers of patients; addition of a lamp to the calling station and retention of lighted door lamps until all calls in a ward have been answered, and the use of resetting keys at points where calls originate. Special care has been taken in the various systems to overcome the danger of lost calls and save time in answering from central points. The new equipment also includes various arrangements of physicians' lighting calls, including the use of lamps of two colors by which nurses may be called independently of doctors, and in case of emergency any doctor desired may then be called to any particular room by signal from the nurse at the bedside.

Fig. 1—Emergency Calling and Resetting Station.

One of the most representative systems consists of a calling and emergency station at each bed, a lamp station in the corridors above the door of each private room and ward, and one or more lamp annunciators, each containing one call and one emergency lamp for each corridor lamp in its territory. In wards a combination calling and resetting

station, consisting of a calling button, emergency button and lamp, is used. When a patient pushes the calling button a lamp is lighted outside the door of that particular private room or ward (if in a ward a lamp above the bed of the patient is also lighted), and the corresponding call lamp in the annunciator in the nurses' duty room is lighted. These lamps stay alight until a nurse gets to the bed and frees the locking device in the button, which extinguishes the lamp. If the call is from a ward and there are two or more calls from that ward at the same time, the releasing of the button extinguishes the lamp over the bed of the patient who is being attended to; but the lamp outside the door of the ward and its corresponding lamp in the annunciator remain alight until all the calls have been attended to in that ward.

If the services of a doctor are required, the nurse presses the emergency button, which lights a corresponding green lamp in the annunciator. This lamp remains alight until the doctor arrives at the bedside. The nurse then releases

Fig. 2—Single-Lamp Station.

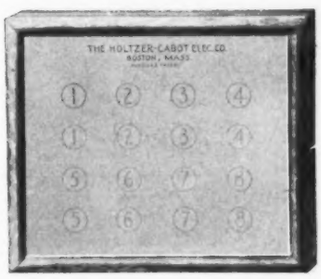


Fig. 3—Emergency-Lamp Annunciator.

the locking device in the button, extinguishing the green light. In case of an emergency the green lamp can be flashed at will by pressing the button repeatedly. All the equipment of these systems is designed with special care to obtain excellent finish, and the apparatus is a pleasing contrast to the temporary devices of limited scope generally employed in this field. Among the latest hospitals to be provided with Holtzer-Cabot signaling equipment are the New England Deaconess Hospital, Boston; the Providence City Hospital, Providence, R. I.; the Petersburg Hospital, Petersburg, Va.; the James C. King Institution, Chicago, and the Collis P. Huntington Hospital, Boston.

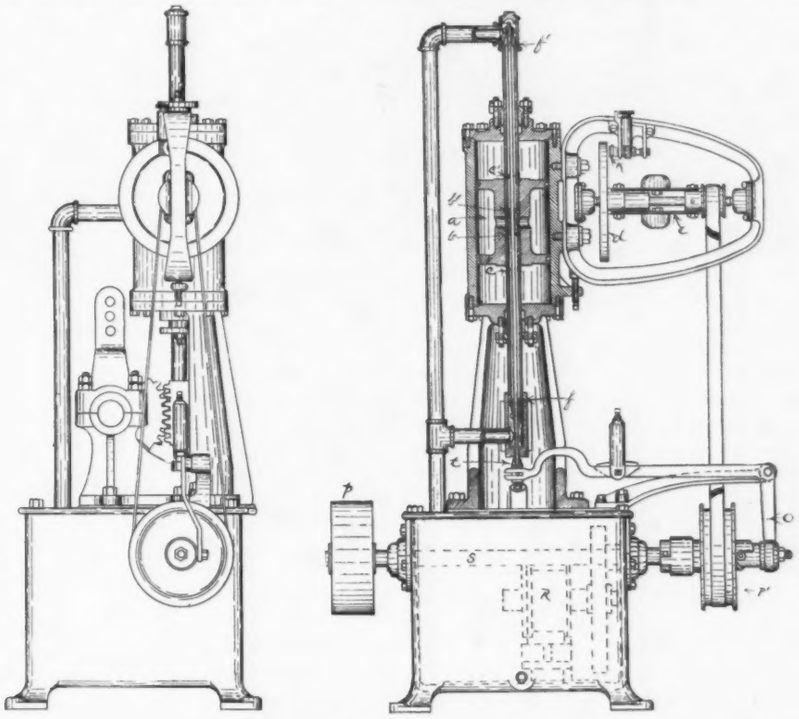
OIL-PRESSURE AUTOMATIC WATER-WHEEL GOVERNOR.

The accompanying illustrations show a Dickerson automatic water-wheel governor, which is being placed on the market by the general agents of the company, Messrs. Burt & Yates, of Salt Lake City, Utah.

The governor is of the oil pressure type, and the illustrations show only one of the five types manufactured by the company. The principle is, however, the same in each.

The governor is self-contained and is sent out ready to be attached to the valve mechanism of the water-wheel. The annular space *a* serves the purpose of a pressure oil tank. The valves *b* and *b'* admit the oil to the cylinder at *c* or *c'* and force the cylinder to move up or down as the speed of the water-wheel may require. The drive pulley *p* is belt-connected to the shaft of the water-wheel and is direct-connected to the shaft *s*, to which is attached the pump *r* and the controlling pulley *p*. This is belt-connected to the fly-ball mechanism *e*, which carries the disk *d* at the other end of the fly-ball springs.

When the speed is normal the disk *d* is brought into contact with the buffer *k*. This can easily be adjusted by a micrometer screw for any desired speed. If the speed attempts to exceed normal, the disk *d* presses hard against the buffer *k* and retards the controlling pulley *p'*, which causes the cam sleeve on *p'* to force out the lower arm of the bell crank *o*. On the other end of this bell crank is



Automatic Water-Wheel Governor.

the valve stem *t*, which controls not only the admission valves *b* and *b'*, but also the exhaust valves *f* and *f'*.

When the speed of the water-wheel is normal the valves all stand half open, allowing half of the stream of oil to pass into each side of the piston and out again through the exhaust valves. The slightest increase of speed will open the upper admission and close the upper exhaust valves, closing the lower admission and opening the lower exhaust valves, thus instantly forcing down the piston and shutting off the water until normal speed is again established. A decrease in speed reverses all these operations.

The company claims for the governor that it will give perfect regulation with any standard make of water-wheel designed to be governed, and that it will shut off the water automatically in case of short-circuit or excessive overloads. It guarantees the governor to regulate within less than 1 per cent variation from normal with 90 per cent change of load, and within less than 2 per cent variation with the instant releasing of normal load. The governor is capable of a broad range of adjustment so that it can be adapted to any conditions. It starts to correct the speed the instant the speed varies from normal, but can be adjusted to take more time to complete the opening or closing of the gates when desired.

ELECTRICALLY HEATED SAMOVAR.

The word samovar is of Russian origin and designates the metal urn used in Russia for making tea, being filled with water which is heated by charcoal placed in a pipe with chimney attached, which passes through the urn. It was but following the natural trend of the times to substitute an electric immersion-type heater for the charcoal

Fig. 1—Electrically Heated Samovar.

and chimney, and the result is the electrically heated samovar. The samovar possesses the advantage in that it is possible by its use to make the tea on the table, and the tea therefore can be served at the desired temperature. The outfit consists essentially of the elements shown in Fig. 2.

The stand, tea urn, spacing ring, tray and cover are all formed from heavy sheet copper. The tea ball, which opens to receive the tea and which hangs from the lowering and raising chain, is of perforated and tinned sheet copper. The tea urn can be readily removed from the stand for cleaning, as it is attached thereto with a three-point bayonet joint.

The heater is of the Westinghouse cylindrical immersion type. Inasmuch as the active portion of this heater is wholly submerged in the liquid in the tea urn, all of the heat developed passes into the liquid. It is due to this feature that the device is exceptionally efficient and economical. The heating element is hermetically sealed within the copper jacket of the heater and is in intimate contact with, but insulated from, the walls thereof. The construction effectively protects against oxidization of the heating element. The heater can be used for heating liquids in any vessel that will contain it and is supplied separately by the manufacturers. A silk-covered cord, a control switch and

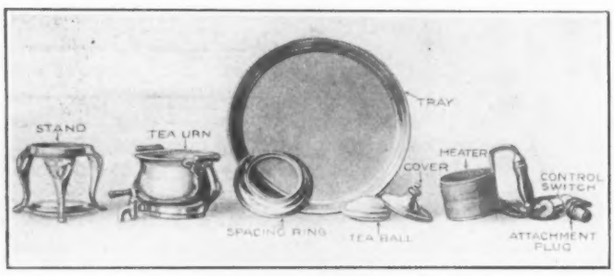


Fig. 2—Elements of Electrically Heated Samovar.

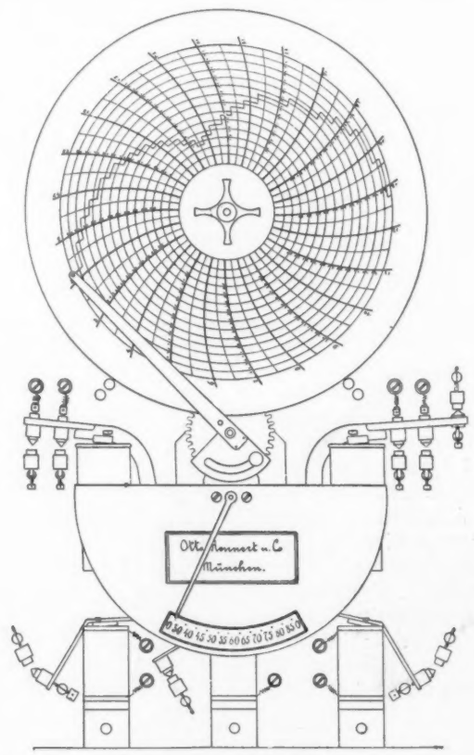
a separable attachment plug are furnished as a part of each heater.

One heat only has been arranged for in the tea samovar. This will raise water in the urn rapidly to the boiling temperature at which tea should be made, and the circuit can then be disconnected. A single pole telescopic switch that is always cool is inserted in the cord, conveniently close to the samovar, by which the circuit may be opened or closed. The metal parts are finished in either nickel or polished copper, while the handles have a rich ebony finish.

REMOTE-CONTROLLED TEMPERATURE OR PRESSURE RECORDER.

The device illustrated in the sketch herewith provides electrical means for automatically recording at a distance variations in temperature or pressure at its controlling station. A number of uses will suggest themselves for power plants, hot-rooms, cold-storage houses, sugar refineries, breweries, matting plants, etc.

For recording temperature variations a mercury-contact thermometer is used, while for pressures the liquid-metal type of manometer can be applied. The change in temperature or pressure effects a corresponding opening or closing of electric circuits connected to the solenoids on the distant registering apparatus. These in turn control the moving system of pointer and stylus shown, enabling the condition at the thermometer or manometer to be read directly and numerically from the scale, while at the same time a graphic record on the moving scale sheet is made by the curve-drawing stylus. The card is revolved by clockwork and can be adjusted to make a complete rotation in one, twelve or twenty-four hours. If desired, alarm contacts can be arranged to engage the travel of the indicating points, so that an undue rise or fall of the distant temperature or pressure will ring an alarm bell at the recording station. In some cases it will be desirable to have several recording devices operated from a single contact-making



Electrically Remote-Controlled Temperature or Pressure Recorder.

control station, one recorder being installed, for example, in the engineer's or machinist's quarters, while another is placed under the eye of the superintendent in his private office. The construction of the recorder illustrated permits a number of such distant recording devices to be controlled from a single contact-making thermometer or manometer. This electrical registering device is made by Otto Rennert & Company, Munich, Germany.

STORAGE-BATTERY MINE LOCOMOTIVE.

Electric trolley locomotives are open to the objection that in mine tunnels with small head room the bare trolley wire is dangerous to employees, and in some mines also the sparks between the trolley and the wire must be avoided. The storage-battery locomotive overcomes all these objections. It has ample power, is very compact and can operate almost continuously if the batteries are carried

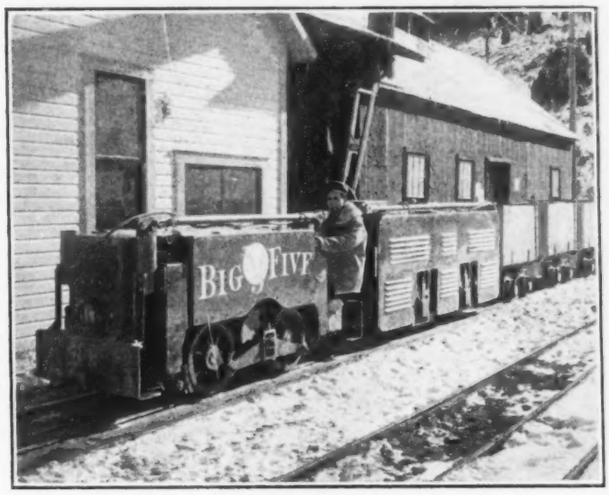


Fig. 1—Storage-Battery Mine Locomotive.

in an auxiliary tender which can be changed at intervals. An installation of this kind has recently been made at the Big Five Tunnel, Ore Reduction & Transportation Company, Idaho Springs, Col. This locomotive, which is shown in Fig. 1, handles trains of thirty cars of 2½ tons each at a speed of 4½ miles per hour. The gage of the track is 24 in. The locomotive has two 17-hp motors and has a maximum height over all of 50 in.; width, 38 in.; length, 108 in. The Edison storage battery was chosen for this service on account of its light weight, ability to withstand shock and vibration and because it can be charged at a high rate. The battery equipment is placed on the tender and consists of 208 cells of the "A-6" type giving 250 volts and rated at 225 amp-hours. This high voltage was chosen

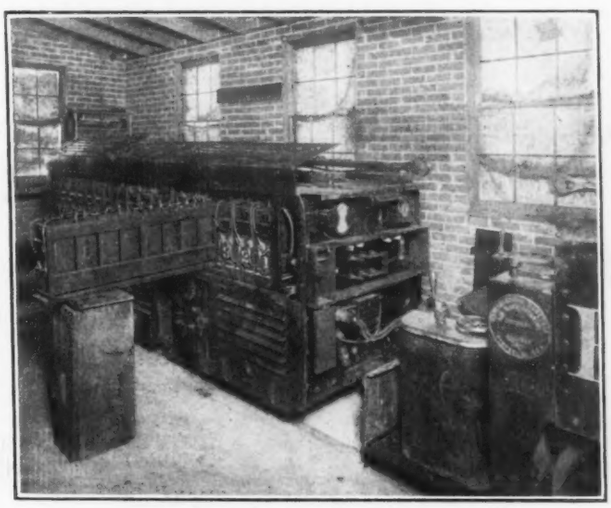


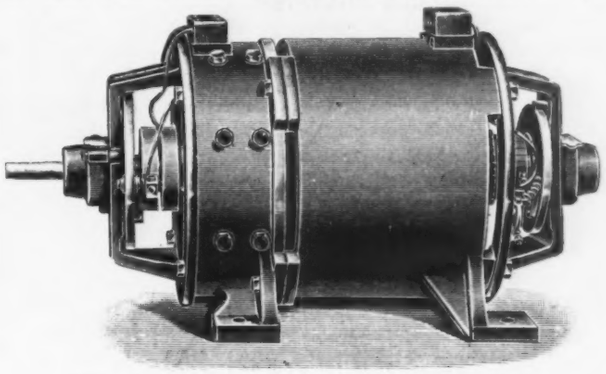
Fig. 2—Arrangement of Battery.

so that the locomotive can also be operated from an overhead trolley outside the mine. The battery furnishes energy for five round trips over a 3-mile route. The present tonnage of the mine is entirely handled on one charge per day. Fig. 2 shows the arrangement of the battery in the tender.

The locomotive was built by the Westinghouse Electric & Manufacturing Company under specifications prepared by Messrs. Barnes & Youtsey, engineers, Denver, Col.

DIRECT-CURRENT TO ALTERNATING-CURRENT CONVERTER.

In the accompanying illustration is shown a machine for converting direct-current energy into alternating-current energy. It consists of a direct-current motor mounted in the same case with an alternating-current generator. The



Direct-Current to Alternating-Current Converter.

alternator is built with either four or eight poles. By means of a shunt-field circuit regulator the speed of the driving motor can be varied over such a range that the four-pole alternator will deliver any frequency from 40 cycles to 60 cycles per second, and the eight-pole unit from 80 cycles to 125 cycles. The equipment has been developed for use with X-ray apparatus, for generating ozone, or for high-tension insulation testing where only direct current is available. It has been placed on the market in ratings from 100 watts to 2000 watts by the Crypto Electrical Company, 149 Bermondsey Street, London, S. E., England.

INCANDESCENT LAMP TESTER.

The incandescent lamp tester shown herewith provides a quick and ready means for ascertaining the energy con-

Incandescent Lamp Tester

sumed by incandescent lamps and enables rapid comparisons to be made between a tungsten and carbon-filament lamp by showing the variation in energy consumption. One end of the device is fitted with a plug for screwing into an

ordinary lamp socket, while at the other end is a receptacle for receiving the lamp to be tested. The meter itself is a milli-ammeter, and intended for use on either direct-current or alternating-current circuits. It has jeweled bearings with hardened polished pivots, and is said to be accurately calibrated. The instrument may also be used as an independent milli-ammeter for other purposes up to the limit of its range. A table showing at a glance the watts corresponding to the readings of the instrument at various voltages forms part of the equipment, which is finished in nickel and hard rubber, and is made by the Eldredge Electric Manufacturing Company, Springfield, Mass.

OIL SWITCHES.

The various methods proposed for the interruption of the arc which invariably occurs in the opening of a circuit containing energy can be roughly divided into two kinds, namely, those which prevent the formation of an arc of great magnitude, and those that interrupt the arc after its formation has occurred. To the second class belong such devices as magnetic blow-outs, air blasts and carbon breaks, which are usually employed with direct current. To the first class belong more particularly the devices used with alternating currents, in which the arc is reduced to a minimum by immersing the contacts in a bath of oil and allowing the oil to quench the arc. As the alternating current passes through the zero point at frequent intervals, the oil is enabled to interrupt the arc at this zero point when it is unsupported by voltage. As direct-current circuits have no zero point, they cannot be as successfully opened as are alternating-current circuits by this type of construction. Various schemes have been proposed and tried for interrupting currents of high energy, such as oil blasts, etc., but all large oil switches for controlling such currents are now so arranged that the arc is broken at the bottom of the oil-containing receptacle, a large pressure of oil thus being available at the instant of break.

The Condit Electrical Manufacturing Company, Boston, in the first type of oil switches which it manufactured many years ago, broke the arc at the bottom of the oil, under a large head. This was eminently satisfactory so far as breaking qualities were concerned, but, owing to the crude form of contacts which were employed at that time, in the case of large capacity switches the mechanical

Fig. 1—Switch Built for 15 Amp, 500 Volts.

pressure was such that it was deemed advisable to change the construction to the common type in which the arc is broken at the top. Owing, however, to numerous improvements, the Condit company now produces a mechanically good switch which breaks under the deep pressure of oil, several types of which are shown in the accompanying illustrations. Foremost among these improvements may be mentioned the new type of laminated brush employed by the Condit company, which enables a good, reliable low-resistance contact to be maintained without undue pressure. This brush is not bent up and milled to shape, but each leaf is punched separately to the proper length, and the length of the leaf and the bend in the leaf are so related that a distinct air space is obtainable between the ends of the leaf when the breaker is closed.

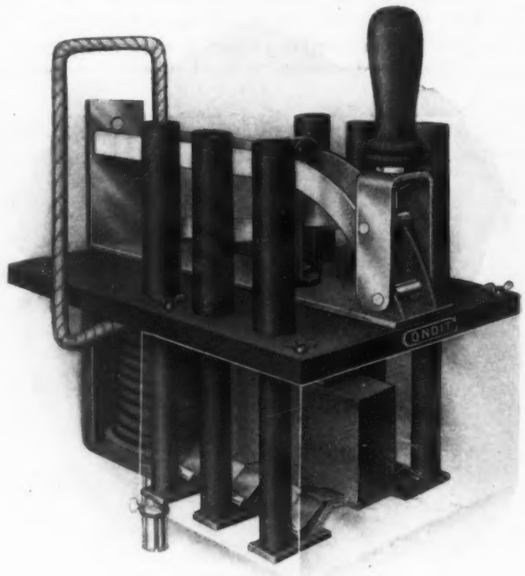


Fig. 2—Switch Built for 100 Amp, 500 Volts.

This change of construction has practically doubled the kilowatt rating that the switches will break without increasing their physical dimensions, and they are, it is claimed, in every respect as reliable, accurate and dependable, mechanically and electrically, as the older type switches of the Condit company, and vastly superior in their current-breaking qualities.

These switches are also made for voltages up to and including 100,000, and for currents up to and including 5000 amp. They are made for hand operation, electrical operation, pneumatic operation, with over-load trip, reverse-power trip, time-limit trip, in subway type and in pole-line type—the line, in fact, covering the entire range of oil switches.

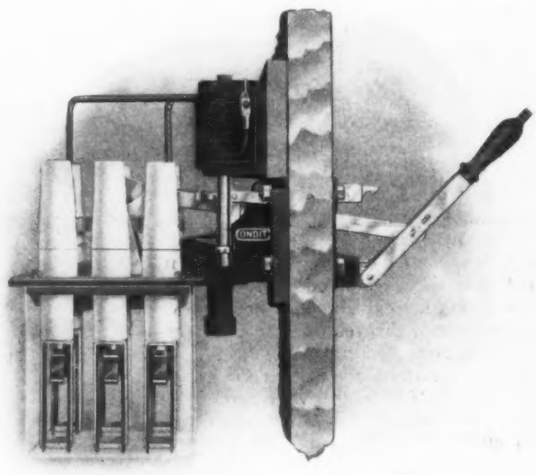


Fig. 3—Switch Built for 1200 Amp, 660 Volts.

General News

ALTHOUGH the conservative tone that characterized transactions in 1911 is noticeable in the majority of opinions on the business outlook for the present year, predictions that the record of 1912 will surpass that of its predecessor are justified in a large measure by the trend of events in the past few months. The increase that took place in the buying of supplies of all kinds in the last quarter of the year, while due in part to necessity to replenish stocks after a long period of narrow purchasing, shows no signs of abatement, and this movement, most pronounced in the iron and steel trades, is an almost convincing indication of growth of confidence in the future. Another noteworthy phase of the trade situation is the decreasing apprehension toward trust investigations and other political disturbances that checked progress in 1911. Enlightenment on the meaning of the anti-trust law and formulation of a plan for the guidance of business interests in conforming to its requirements are among the most important developments that can be brought forth in the present year. The stock markets have been active since the beginning of the year, and prices have shown general improvement. Rates in the money market Jan. 3 were: Call, 3@3½ per cent; ninety days, 3¾@4 per cent.

THE COPPER MARKET.

Heavy exports in the closing days of December brought the shipments for the month to 37,430 tons, which compares with 31,517 tons in December, 1910, and with 37,685 tons in December, 1907, the largest monthly total ever reported by the government. Trading in the domestic market has been light since the holidays and prices have shown little change. Electrolytic has been quoted at about 14¼ cents and predictions have been made of the probability of increase after publication of the December statement of the Copper Producers' Association on Jan. 8. This is expected to show a decrease of over 10,000,000 lb. in stocks of marketable copper in the United States. Foreign statistics of Jan. 2 showed that stocks in England and France decreased 1470 tons since Dec. 15, while the large exports from the United States brought about an increase of 710 tons in the visible supply abroad, this being reported as 57,280 tons at the close of December. Conditions abroad have shown but little change since the first of the year, the markets remaining quiet, with few price changes of importance. A review of conditions in the copper industry during 1911 is given in another section of this issue. Exports for the month, including Jan. 3, aggregate 1020 tons. The daily call on the Metal Exchange Jan. 3 quoted copper as per the accompanying table.

Standard Copper.	Bid.	Asked.	Settling Price.
Spot	15.75	14.12½	.....
January	13.75	14.12½	13.92½
February	13.75	14.12½	13.92½
March	13.80	14.12½	13.97½
April	13.80	14.12½	13.97½
May	13.80	14.12½	13.97½

The London market, Jan. 3, was as follows:

	Noon. £ s d	Closing. £ s d
Standard copper, spot	63 13 9	63 11 3
Standard copper, futures	64 10 0	64 7 6

Best selected copper:

January 3	£67 15s 0d
January 2	67 15 0
December 29	67 15 0

INDUSTRIAL AND COMMERCIAL NOTES.

10,000-hp Low-Head Turbines for the Keokuk Water-Power, Largest Ever Built.—Shipment has already begun on the preliminary parts of the 10,000-hp vertical waterwheels which will be installed in the Keokuk hydroelectric plant of the Mississippi River Power Company. On account of their unusual rating and the comparatively low hydraulic head, 32 ft., at which they are to operate these waterwheels will be by far the largest ever built. Their runners alone will weigh 130,000 lb. each, the largest turbine runner heretofore constructed weighing but 30,000 lb. The turbines complete will weigh nearly 1,000,000 lb. apiece and have required the construction of special cars and railroad-clearance routings to convey them to the site of the plant at Keokuk, Ia. The power house, which has been described in these columns, is being erected for thirty 10,000-hp units, the first fifteen of which have already been contracted for. These great machines, which are to have overload ratings of 14,000 hp, will be of the vertical-shaft type, operating at 57.7 r.p.m. and carrying umbrella-type alternators mounted at the floor level. In spite of the low rotative speed of the turbines, the generator pressure will be 20,000 volts. The turbine equipment is being designed and built by the Wellman-Seaver-Morgan Company, of Cleveland, Ohio, while the alternators will be furnished by the General Electric Company.

National Electric Supply Jobbers' Meeting.—The entertainment and social features in connection with the meeting of the National Electrical Supply Jobbers' Association, to be held in Cleveland, Feb. 13, 14 and 15, are being arranged under the auspices of the Electrical League of Cleveland, and the preparations are well under way. On the evening of Feb. 13 a "rejuvenation" of the Sons of Jove will be conducted under the charge of Philip S. Dodd, secretary of the commercial division of the National Electric Light Association. A valentine entertainment and smoker will be held at Gray's Armory on the evening of the 14th, where the members will be seated at tables. A novel and an elaborate program is being prepared by the entertainment committee, of which H. H. Cudmore of the Brilliant Electric Company is chairman. J. T. Kermode, of the Cleveland Electric Illuminating Company, has charge of the decorations of the armory, which will be largely electrical in character and appropriate for the occasion. Mr. N. C. Cotabish, of the National Carbon Company, is chairman of the sight-seeing committee, under the auspices of which the jobbers will be taken in automobiles to various points of interest, including the plants of the National Electric Lamp Association and the National Carbon Company on the afternoons of Feb. 14 and 15. J. Robert Crouse, of the National Electric Lamp Association, is chairman of the finance committee. The headquarters of the jobbers' association will be at the Hollenden Hotel and the meetings will be held there.

Montgomery Light & Traction Company.—L. D. Mathes, the newly appointed general manager of the Montgomery Light & Traction Company, of Montgomery, Ala., has arrived in Montgomery and taken up his work. The Montgomery Light & Traction Company is practically owned by Richard Tillis, an influential and wealthy citizen of Montgomery. It is a consolidation of the Montgomery Traction Company and the electric light and power business of Richard Tillis, including a new 5000-kw steam turbine plant just completed by Mr. Tillis. With its new power plant the Montgomery Light & Traction Company is expected to save approximately $50,000 a year which the Montgomery Traction Company has been paying one of the other electrical companies in Montgomery, as well as to compete generally for the furnishing of electric light and power throughout the city. Mr. Mathes has made a most enviable reputation as general manager of the Union Electric Company, of Dubuque, Ia. With a modern power plant and the only street railway in Montgomery, he will have ample opportunity of adding to his laurels owing to the keenly competitive conditions in the electric lighting and power business of Montgomery.

Will Review Long Acre Proceedings.—The Long Acre Electric Light & Power Company has withdrawn its motion before the Appellate Division of the Supreme Court to quash a writ of certiorari that was granted to the New York

Edison Company for the purpose of reviewing the action of the Public Service Commission for the First New York District in giving the Long Acre company a certificate of public necessity and convenience and permission to issue securities to cover expenses of building a plant. The attorneys for the Edison company, in asking the writ, contended, as previously stated in these columns, that the case was a proper one for the court to establish the precedent that no issue of securities shall be approved until the Public Service Commission has decided in the applicant's favor upon the question of public necessity and convenience. They also contended that it would be an injustice to permit the Long Acre company to compete with the New York Edison Company in view of the fact that the policy of the State in regulating the rates, terms, etc., of service to customers of public-service corporations permits a form of restricted monopoly in which the Edison company should be protected. The attorneys for the Long Acre company, in withdrawing their motion, took the ground that this action on their part will bring the entire matter of the certificate before the courts on its merits.

Public-Service Commission Regulation.—The change of view toward the value of public-service commission regulation by electrical public-utility corporations is illustrated occasionally in circulars and advertisements relating to new securities offered for sale. Recently one of the largest electrical operating corporations in the country, and one which formerly was none too friendly toward commission regulation, supported its offer of new securities by reference to the valuation of its properties by a State commission and by the statement that the company is subject to commission regulation, and that the securities offered for sale are issued with the approval and authority of the commission.

Incorporations in 1911.—According to the *Journal of Commerce*, New York, papers filed in the Eastern States in December for companies with an authorized capital of $1,000,000 and over involved a par value of $159,450,000, making a total for the year of $1,837,431,400, which is $130,186,050 under the total of the previous year. Charters taken out by large companies in states other than those in the East amounted to $27,500,000 during December, and to $409,540,000 for the year. Charters taken out by other companies, with an individual capital of $100,000 or more, but under $1,000,000, during December aggregated $35,559,000, which made a grand total of $2,889,381,150 for 1911.

Electrical Representation in Chicago Association of Commerce.—The large ways and means committee of the Chicago Association of Commerce embraces some seventy or eighty sub-committees representing various industries. Sub-committee No. 31, which is made up of men engaged in the making or selling of electrical goods, lighting supplies, wire and fixtures, has been named for 1912, as follows: Charles H. Roth, Roth Brothers & Company, chairman; Thomas C. Ringgold, Central Electric Company; N. B. Parsons, Belden Manufacturing Company; J. W. Bolte, Bolte & Weyer Company; James M. Gilchrist, Federal Electric Company.

Erie Works of the General Electric Company.—Four hundred molders are now regularly employed in the new foundry of the General Electric Company's works at Erie, Pa. The blast furnaces run two heats daily, the castings being shipped to the Schenectady and Lynn factories for finishing. Among recent large pieces of work turned out at the Erie foundry have been the frames of several 20,000-kw steam turbines. The company also plans to build its gas-electric cars for railway-feeder service at Erie, and now has a large force of machinists at work preparing tools and dies for these parts.

Report of New York Edison's Power Bureau for 1911.—During the past year the New York Edison Company's Bureau of Isolated Plants closed down forty-one private plants, which represents an increase of 1708 hp and 48,800 incandescent lamps in the connected load of the company. The bureau also secured seventy-eight break-down contracts, with an aggregate maximum-demand capacity of 1539 kw. The company now has about 195 break-down contracts with operators of private plants.

Factory for Electra Cars.—The Storage Battery Company, which manufactures the Haschke storage battery, the Electra automobile and electric boat propellers, has secured the former factory of the Economy Motor Car Company in Joliet, Ill., and is now arranging to build the Electra car in large quantities. This electric runabout was described in the *Electrical World* of Sept. 23, 1911, and has attracted considerable attention, both in this country and abroad.

The Diesel Engine.—In response to inquiries by the *Electrical World* regarding a report to the effect that the General Electric Company would take over the manufacture and sale of the Diesel engine in the United States, an officer of the company said on Tuesday, "Nothing whatever has been decided as to the manufacture of Diesel engines by the General Electric Company, and we are not manufacturing them at present. You may take this as authoritative."

Stone & Webster Changes.—Announcement is made that Dwight P. Robinson and John W. Hallowell became partners in the firm of Stone & Webster, of Boston, on the first of the year. The other members of the firm are Charles A. Stone, Edwin S. Webster, Russell Robb, Henry G. Bradlee and Eliot Wadsworth.

Financial

Allis-Chalmers Affairs.—On Dec. 30 announcement was made that interest on the first-mortgage 5 per cent bonds of the Allis-Chalmers Company, due Jan. 1, would not be paid. The immediate assumption was that the company would pass into the hands of a receiver. The *Electrical World* is able to state that a receivership is not a necessary consequence of last week's announcement. One of the highest officials of the company states that the bondholders' and stockholders' committees are working in harmony with the company on measures that will accomplish the conservation of the property, and that there are excellent prospects that the plans now under consideration will place the company in better condition than ever. The company still has an unimpaired working capital of $7,000,000, as stated in the *Electrical World* in the issue of Dec. 30, 1911. The disposition of the bondholders is to treat the stockholders fairly; in fact, there appears to be no conflict between the elements working for the rehabilitation of the company. As to a receivership, which was so promptly and confidently predicted by the daily press, it is pointed out that the trustees under the first mortgage, on which the January interest has been declared "not payable," could not force a receivership in less than ninety days, even if there were a disposition to take this step. Within three months it is hoped that a readjustment will be worked out which will render receivership proceedings entirely unnecessary. No change is to be expected in the manufacturing policy of the company. The formal statement that has been issued by the company reads as follows: "The directors of the Allis-Chalmers Company, at the meeting held to-day, decided that, in view of the continued depression in business affecting especially this company, the decrease in earnings and the curtailment of credits, it would not be advisable to pay the interest on the first-mortgage 5 per cent bonds coming due Jan. 1, 1912. The directors were of the opinion that the business could not be profitably continued in the future unless additional working capital was supplied and the fixed charges reduced, and that additional working capital could only be obtained by a readjustment of the company's capitalization. Under the circumstances the directors felt that they were not warranted in using the cash in the treasury except for the payment of merchandise creditors, pay-rolls and taxes. These current obligations will be paid as they mature and funds are available for that purpose. It is hoped that a satisfactory arrangement can be made for the extension of the other current obligations maturing in the near future. The stockholders' committees are endeavoring to agree with the bondholders' committee upon a plan of readjustment of the capitalization of the company which will provide for adequate capital and a reduction of fixed charges. It is expected that such a plan will be shortly submitted to the security holders for their approval." The bondhloders' protective committee has arranged with the Central Trust Company of New York, its depositary, to advance to the bondholders the amount of interest due them Jan. 1, upon

security of the bonds with coupons attached deposited with the trust company. The latter will charge 5 per cent annual interest on the amount advanced. This is virtually a loan, the bondholder giving a $1,000 bond with a $25 coupon for security for a $25 loan, the 5 per cent semi-annual interest on his bond, for which he has to pay an interest charge of 5 per cent. It is rather generally believed that the reorganization plan will call for assessment of both preferred and common stocks, and that the bonded indebtedness will also be materially decreased so as to curtail fixed charges. Just what disposition will be made of the first mortgage 5 per cent bonds has not been disclosed, but there is an inclination to believe that bondholders will be asked to take new preferred stock in whole or in part for their bonds.

Organization of Public Service Company of Northern Illinois.—The combination of the North Shore Electric Company, Economy Light & Power Company, Illinois Valley Gas & Electric Company, Chicago Suburban Light & Power Company and Kankakee Gas & Electric Company into the Public Service Company of Northern Illinois made necessary some changes and reorganization of staff appointments. The territories now served by one large company cluster about Chicago on the north, west and south, and it is interesting to note that Zion City, north of Chicago, and Havana, Ill., to the southwest, both in the territory of the Public Service Company of Northern Illinois, are 200 miles apart in a straight line. This does not mean, however, that all the intervening territory is served by this company. The headquarters of the company are in Chicago and Samuel Insull is president. The vice-presidents are Frank J. Baker, formerly of the North Shore Company, and Charles A. Munroe, formerly of the Economy Company. Mr. Baker is in charge of the operating department and Mr. Munroe of the commercial department. George H. Lukes is the general superintendent of the company, with headquarters at the Chicago office. He reports to Mr. Baker. The territory served has been divided, for operating purposes, into four divisions and thirteen districts. Superintendents of divisions will be located as follows: Northern division, John S. Reesman, Evanston; western division, Harry L. Judd, Oak Park; southern division, James M. Strasser, Joliet; eastern division, Oliver L. Hyatt, Chicago Heights. It was found most satisfactory to operate two districts independently of divisions. These are known as District E, of which L. C. Stephens, of Crystal Lake, is superintendent, and District M, of which C. F. Stevens, of Mendota, is superintendent. For new business purposes, the extensive territory of the company has been divided into two grand divisions, John G. Learned being responsible as contract agent for the territory north of the southern limits of Chicago, and Edward Curry being in charge in the territory south of that line. Mr. Learned was formerly with the North Shore Company, and Mr. Curry with the Economy Company. Both Mr. Learned and Mr. Curry report to Vice-President Munroe.

Adirondack Electric Power Corporation Succeeds Hudson River Power Companies.—The Adirondack Electric Power Corporation, with a capitalization of $12,000,000, of which $2,500,000 is 6 per cent preferred stock, and with its principal office in Saratoga, N. Y., has filed a certificate of incorporation. The new company will succeed the Hudson River Electric Power Company and its affiliated companies, which were sold to the bondholders' committee under foreclosure last August. The directors of the company are: John P. Reynolds, Francis M. Edwards and James R. Hooper, of Boston; Wilson A. Shaw and Charles E. Willock, of Pittsburgh; Senator Edgar T. Brackett, of Saratoga Springs; John S. Scully, of Washington, and Edward S. Webster, of Chestnut Hill, Mass. All of the directors, excepting Messrs. Brackett and Edwards, compose the bondholders' committee referred to above. The officers are: President, James R. Hooper; vice-president, Charles E. Willock; secretary, Francis M. Edwards; treasurer, William H. Blood, Jr. The Stone & Webster Management Association of Boston will act as managers of the company.

Housatonic Power Company Transferred to United Light & Water Company.—Control of the Housatonic Power Company of New Haven, Conn., to which the New York, New Haven & Hartford Railroad Company had transferred control of its gas, electric light and power companies in Connecticut, was transferred Jan. 3 to the United Light & Water Company, a new company chartered in Connecticut, in accordance with the plan outlined in these columns Dec. 16, 1911. The new company will hold the properties under a lease dating back to Oct. 1, 1911, and running for 99½ years. The United Light & Water Company, contrary to report, is not owned or controlled by the United Gas & Improvement Company, of Philadelphia, which was active in getting the New Haven road to take the properties originally, but is a new and independent concern having no connection with any existing operating company. The project of leasing the properties to the United Light & Water Company was conceived by the late Alden M. Young, its president. His successor in this company has not been appointed. Other officers of the company are M. J. Warner, of Branford, Conn., vice-president; Arthur Perkins, of Hartford, Conn., secretary; Richard Sutro, of Sutro Brothers & Company, New York, treasurer, and Alexander T. Campbell, of New London, general manager.

Kentucky Utilities Company.—Substantiation of the report printed in these columns to the effect that a big company, capitalized at between $10,000,000 and $20,000,000, and known as the Kentucky Utilities Company, would be formed by Eastern capitalists to take over electric light and power properties in Frankfort, Owensboro, Henderson and other important Kentucky cities has been given. Options are now being solicited by several of the largest stockholders in the Capital Gas & Electric Lighting Company of Frankfort, and the negotiations are said to be in the hands of T. Lindsay Fitch, of Louisville, Ky., the largest single shareholder in the company. Superintendent Frank Austin, of the Capital company, is expected to confer with Mr. Fitch in Louisville shortly relative to the proposed merger.

Southern Telephone Changes.—Following the offer of the American Telephone & Telegraph Company to exchange its stock for the outstanding minority stock of the Cumberland Telephone & Telegraph Company, as mentioned in these columns Nov. 18 and 25, 1911, it is now proposed to form an operating amalgamation between the Cumberland company and the Southern Bell Telephone & Telegraph Company. Both of these companies are controlled by the American Telephone & Telegraph Company, and the operating amalgamation mentioned above is in keeping with the policy of the parent company of grouping its subsidiary operating companies so as to obtain maximum efficiency and economy of operation.

Pacific Power & Light Company Increases Capital Stock.—At a meeting held Dec. 29, 1911, stockholders of the Pacific Power & Light Company of Portland, Ore., which is controlled by the American Power & Light Company, 71 Broadway, New York, voted to increase the capital stock of the company from $7,500,000 to $12,000,000. The purpose of increasing the capitalization of the company was to liquidate the floating debt and to provide additional working capital for the further growth of the company's business. The company now operates over 440 miles of high-tension transmission system and has, in addition, nearly 400 miles of lower voltage distributing lines in service.

New York Railways Company Succeeds Metropolitan.—The Metropolitan Street Railway system was sold Dec. 29, 1911, to bondholders for $12,000,000, and its name has been changed to the New York Railways Company. Theodore P. Shonts, president of the Interborough-Metropolitan Company, is the head of the company, and will operate it in conjunction with the subway and elevated lines.

American Brass Company Consolidates Subsidiaries.—On Jan. 1 the American Brass Company, which does a large part of the brass business of the country, did away with its principal subsidiaries and consolidated their business under one head.

MARKET PRICES.

	Dec. 27.	Jan. 3.		Dec. 27.	Jan. 3.
Allis-Chalmers	1⅜	1⅜	General Electric.....	154	155¼
Allis-Chalmers, pf....	8	8*	Mackay Companies...	80	78½*
Amalgamated Copper.	66½	66	Mackay Companies, pf.	69	69¾*
Boston Edison.....	290	296	Philadelphia Electric.	16⅞	17⅝
Commonwealth Edison	135½	125½*	Western Union.....	79	79⅞
Elec. Storage Bty...	53⅝	53	Westinghouse	66½	68
Elec. Storage Bty., pf.	30*	30*	Westinghouse, pf....	117½	117½*

*Last price quoted.

Personal

Mr. Calvert Townley was married Dec. 30 at Memphis, Tenn., to Mrs. Mabel McCormick Steele.

Mr. R. S. Satterlee, formerly second vice-president of the Habirshaw Wire Company, New York, has been elected president of the company.

Mr. George Winkler, vice-president of the Burke Electric Company, was married at Erie, Pa., Dec. 2, to Miss Clare L. Maus. Following the ceremony the couple left for a Southern trip.

Mr. W. Godfrey Boyd has been appointed a special engineer for the Standard Plunger Elevator Company, of Worcester, Mass. Mr. Boyd's headquarters will be at 1307 Euclid Street, Washington, D. C.

Mr. Leonard A. Busby has been elected president of the Chicago City Railway Company, suceeding Mr. T. E. Mitten, resigned. Mr. Busby is a practising lawyer and has been general counsel of the company.

Mr. Charles F. Stark has resigned as assistant to Advertising Manager D. H. Howard, of the Commonwealth Edison Company, Chicago, and is now commercial agent of the Essanay Film Manufacturing Company..

Mr. A. T. Selzer has been appointed Chicago manager for the Adams-Bagnall Electric Company, succeeding Mr. James G. Pomeroy, promoted to be sales manager of the company at the home office in Cleveland.

Mr. E. Hagenah, who has been associated with the Westinghouse Electric & Manufacturing Company at Chicago, has been made chief engineer for the Springfield Light, Heat & Power Company at Springfield, Ill.

Mr. Leonard J. Lewinson, of the Electrical Testing Laboratories, will deliver a lecture on "Modern Forms of Incandescent Lamps" before the Electrical Engineering Society of Columbia University on the evening of Thursday, Jan. 11.

Mr. J. G. Light, who has been in charge of the Ottawa (Ill.) office of the Public Service Company of Northern Illinois, has been appointed manager of the properties of that company at Marseilles, Ill., to succeed Mr. Thomas R. Ford.

Prof. Dugald C. Jackson, of Boston, has been appointed arbiter on behalf of the Woonsocket Electric Machine & Power Company, of Woonsocket, R. I., in connection with the determination of the rate for electric energy to be charged the Rhode Island Company.

Mr. Darrow Sage, chief engineer of the Jersey City power house of the Hudson & Manhattan Railroad Company, gave a lecture on "Features of Power-House Operation from an Operating Engineer's Viewpoint," before the Electrical Engineering Society of Columbia University on Jan. 4.

Mr. Robert T. Lozier is the author of a pamphlet just issued by Kountze Brothers, the New York bankers, entitled, "Securities of Electric Lighting Corporations." Included are statistics of the estimated growth of central-station business to 1911 from 1907, the time of the last census report.

Mr. James W. Johnson, district manager for the General Electric Company, with headquarters in Chicago, is taking a needed rest in Florida. Mr. E. C. Loveland, formerly electrical engineer for Swift Company, Chicago, has a fruit farm near Miami, and Mr. Johnson is enjoying his hospitality for a few weeks.

Mr. Walter J. Jones, consulting engineer, 30 Church Street, New York City, has been appointed engineer to the Electrical Commission of the city of Montreal, Quebec. He will have immediate supervision over the work of gathering data and laying out a complete municipal underground-conduit system of that city.

Mr. J. W. Pentecost, general superintendent of the Nashville Railway & Light Company, of Nashville, Tenn., received from the employees of that company a loving cup, which was presented the day after Christmas amid suitable celebrations. It is a handsome silver cup, engraved as follows: "To J. W. Pentecost from the employees of the electric-light plant as a token of friendship and esteem. Christmas, 1911."

Dr. F. S. Pearson, who recently returned from London, is on his way to Mexico for an inspection of the various properties in that country in which he is largely interested. One of the matters to which he will give special attention is the section of the Mexico Northwestern Railway Company, of which he is the president, between Madera and Pearson. This line has just been completed and will be opened within a few days and personally inspected by Dr. Pearson.

Mr. James G. Pomeroy, leaving Chicago to become sales manager of the Adams-Bagnall Electric Company in Cleveland, was the guest of honor at the luncheon of the Electric Club of Chicago on Dec. 27. Mr. Pomeroy has been engaged in the electrical business in Chicago for twenty-three years, and he is highly esteemed. The Electric Club presented to Mr. Pomeroy a handsome leather traveling bag containing a leather-incased set of toilet accessories for travelers.

Mr. Arthur D. Little was elected president of the American Chemical Society at its annual meeting in Washington. Mr. Little, who is president and general manager of Arthur D. Little, Inc., chemists and engineers, Boston, Mass., has previously held the position of vice-president of this society and has been chairman of the division of industrial chemists and chemical engineers. He graduated from the Massachusetts Institute of Technology with the class of 1885, and is a specialist in the chemistry of cellulose and fibers, fiber treatments and papermaking, being the official chemist of the American Paper and Pulp Association and the author of "The Chemistry of Papermaking." He is prominent in connection with the great International Congress of Applied Chemistry which is to be held in this country next year, and is president of the section on starch, cellulose and paper.

Mr. S. D. Sprong has resigned his position as chief electrical engineer of Messrs. J. G. White & Company, Inc., New York, and accepted that of electrical engineer of the Edison Electric Illuminating Company of Brooklyn, retaining the relation of consulting electrical engineer with Messrs. J. G. White & Company, Inc. Mr. Sprong is exceptionally fitted for his duties with the Brooklyn Edison company, having had wide experience in central-station work. Previous to joining the staff of Messrs. J. G. White & Company, Inc., he was electrical engineer for the United Electric Light & Power Company, of New York City, and he was also formerly connected with the New York Edison Company and the Public Service Corporation of New Jersey. Mr. Sprong is a member of the American Institute of Electrical Engineers. He will be attached to the staff of Mr. W. F. Wells, general superintendent.

Mr. George Cutter has retired from the active supervision of the business of the George Cutter Company, of South Bend, Ind., in consequence of the amalgamation of that company and the J. Lang Electric Company, of Chicago. Mr. Cutter retains a position with the George Cutter Company, which is the name of the combined company, as vice-president, but will be able to devote much of his time to his private pursuits. Mr. Cutter is one of the veterans of the electrical industry, and a large number of friends and acquaintances will be interested to know of his partial retirement from business cares. He was born near Boston in 1853, and began his electrical work as far back as 1869, when he started in with Johnson & Whittemore. When the Bell telephone was brought out in 1876 Mr. Cutter was employed by Charles Williams, and he was intimately associated with the introduction of this epoch-making invention. In 1881 he went to Russia for the International Bell Telephone Company, and two years later he returned to this country and engaged as manager of the testing department of the old Thomson-Houston Electric Company, at New Britain, Conn. As chief engineer for the "T-H" Company, he made a second trip to Europe from 1885 to 1887, and not long after that he removed to Chicago, where he started his own business for the manufacture of electrical appliances in 1889. Mr. Cutter organized the George Cutter Company, which designs and manufactures specialties for outdoor electric lighting, in 1898, and this business was removed to South Bend in 1905. Mr. Cutter is a member of the American Institute of Electrical Engineers and always has been greatly interested in both the engineering and the practical side of the electrical industry, which he has seen grow to truly marvelous proportions. He has been a familiar figure at meetings of electrical societies and has done much useful work in perfecting various electrical appliances, as he has marked mechanical skill as well as technical knowledge.

Construction.

MONTGOMERY, ALA.—Improvements to the municipal water-works involving an expenditure of over $20,000 have been authorized by the City Council. The proposed work will include the installation of a 3000-cu. ft. air compressor, electrically driven, at a cost of $15,500.

HURON, ARIZ.—Plans are being considered for the installation of electrical operating machinery at the Hull mines.

FAYETTEVILLE, ARK.—The Fayetteville Light & Power Company has been awarded the contract to supply the city of Springdale, 12 miles distant, with electricity for lamps. Work will begin immediately on the installation of the system.

GRAVETTE, ARK.—The city of Gravette is reported to have issued bonds to the amount of $25,000 for the installation of a municipal lighting plant.

ANTIOCH, CAL.—The proposition to establish a municipal electric light and power plant at Antioch will be submitted to a vote in the near future. It is proposed to secure an engineer to make investigations and prepare plans and estimates as to the cost and operation of such a plant.

FALLON, CAL.—The City Council has passed an ordinance authorizing the establishment of a municipal electric light, heating and power plant in Fallon, for which bonds to the amount of $15,000 will be issued.

GLENDORA, CAL.—The Board of City Trustees is considering plans for the installation of an electric-lighting system on the principal streets of the city.

LINDSAY, CAL.—The Board of City Trustees is considering plans for extensions and improvements to the municipal electric-lighting system, for which funds will soon be appropriated.

LOS ANGELES, CAL.—Specifications for street lighting for the coming year have been prepared. Owing to the lighting companies having objected to extending their distributing systems in view of the uncertainty of the city's plans with respect to the aqueduct power when ready for use, the specifications are divided into two proposals. One is for supplying electricity for the 3203 lamps at present in use, and the other provides for these lamps and in addition for 500 new lamps to be installed during 1912.

OCEANSIDE, CAL.—Plans are being considered by the Oceanside Tent City Company, recently organized, for the installation of a cluster-lighting system on the property to be laid out for a tent city. A. J. Wallace, of Long Beach, Cal., is president of the company and G. A. Lane, of Oceanside, is treasurer.

REDWOOD CITY, CAL.—The Halfmoon Bay Light & Power Company has applied to the Board of Supervisors of San Mateo County for a franchise to erect an electric distributing system in the First Township of San Mateo County. Bids for the franchise will be received until Feb. 5, 1912.

SACRAMENTO, CAL.—The Pacific Electric Railway Company has applied to the State authorities for permission to create a bonded indebtedness of $100,000,000, as recently voted at a special meeting of the stockholders, to be used for extensions and improvements to its system. Paul Shoup is vice-president and general manager.

SAN BERNARDINO, CAL.—The Southern Sierras Power Company will soon begin work on the erection of a private telephone line from Bishop to San Bernardino, a distance of 240 miles. The telephone line will follow the course of the company's transmission line now in course of construction.

SAN RAFAEL, CAL.—A petition has been filed in the office of the Marin county clerk asking the Board of Supervisors of Marin County to call a special election to vote on the proposition to issue $2,000,000 in bonds, the proceeds to be used for the condemnation and purchase of the property of the Marin Water & Power Company, which consists of the two reservoirs of Lagunitas and Williams Gulch, both on Mount Tamalpais, a generating plant and a pipe line that supplies water to the towns of Sausalito, Ross, Corte Madera, Larkspur, Kentfield, San Rafael, San Anselmo, San Quentin and Fairfax.

STOCKTON, CAL.—The City Council has adopted a resolution authorizing the city engineer to prepare plans and specifications for the installation of an underground-conduit system for electroliers in the business district, including police and fire-alarm wires, and also for providing for the calling of an election to vote on the proposition to issue bonds for same.

TROPICO, CAL.—The installation of a municipal electric-light plant in Tropico is reported to be under consideration. The cost of the proposed system is estimated at about $20,000.

VALLEJO, CAL.—Prof. C. L. Corey, head of the electrical department of the University of California, who had been engaged by the city of Vallejo to make an appraisal of the plant of the Vallejo Light & Power Company, has placed the value of the property at $115,000.

GREELEY, COL.—Surveys are being made for the erection of the high-tension transmission line of the Greeley Hydro-Electric Company, which will extend from the Colorado portal of the Greeley-Poudre tunnel by a direct route to Fort Collins and thence to this city. It is proposed to increase the output of the power house at the mouth of the tunnel, which now generates about 400 hp. D. A. Canfield is at the head of the company.

MONTROSE, COL.—The Uncompahgre & Gunnison Valley Railway Company is considering the construction of a new power plant in the coal fields near Delta.

DE LAND, FLA.—The De Land Electric Light, Power & Ice Company, it is reported, will award contract Feb. 11, 1912, for a 250-kw, 60-cycle, three-phase, 2300-volt generator direct-connected to a four-valve engine. E. L. Hon is general manager.

FORT PIERCE, FLA.—The City Council is reported to have engaged D. D. & C. M. Rogers, of Daytona, Fla., to prepare plans for the electric-light plant, for which bonds to the amount of $15,000 were recently voted.

LAGRANGE, GA.—The Georgia Railway & Power Company is reported to have purchased a site and water rights in the northern part of the city. The company proposes to erect a substation from which it will supply electricity for the local mills and other consumers in this section. A substation will also be erected in Franklin.

MONTPELIER, IDAHO.—The Telluride Power Company has been granted a franchise to operate an electric light and power system in Montpelier.

BARRY, ILL.—The local telephone system, owned by C. H. Ware, is reported to have been sold to A. L. Jones for $9,000.

BOWEN, ILL.—The local electric-light plant, owned by James Bennett, was destroyed by fire Dec. 28. The loss is said to be $12,000, with an insurance of $6,000.

COAL CITY, ILL.—The Public Service Company of Northern Illinois is erecting a transmission line to the plant of the Illinois Aero Construction Company, which will use motor-driven machinery in its plant.

FARMINGTON, ILL.—The Silver Creek Colliery Company, it is reported, contemplates asking the City Council for a franchise to operate an electric-light plant and a gas plant in Farmington.

SPRINGFIELD, ILL.—The City Commission is negotiating with the Springfield Light, Heat & Power Company for the purchase of poles, wires and other equipment now owned by the company in East Springfield. The company has a contract for lighting this suburb, but as the city will soon be able to furnish energy from the municipal electric-light plant it is proposed that the city take over the street-lighting equipment and dissolve the contract.

EVANSVILLE, IND.—Application has been made to the Board of Public Works by an independent telephone company, recently organized by E. B. Oslage, for a franchise to operate in Evansville. The company proposes to connect with the independent telephone exchanges of southern Indiana, southern Illinois and western Kentucky.

INDIANAPOLIS, IND.—The County Commissioners have awarded the contract for furnishing light, heat and power for the county court house and jail for the year 1912 to the Merchants' Heat & Light Company, of Indianapolis, Ind., at $13,989. The county power plant will be closed down. It is expected that about $5,000 a year will be saved by securing the service from a private company.

ALTON, IA.—The plant and holdings of the Electric Light & Power Company, it is reported, have been sold to the Mason Plumbing & Heating Company, which, it is said, will improve the plant.

DUBUQUE, IA.—An ordinance has been submitted to the City Council providing for a boulevard system of street-lighting.

FORT DODGE, IA.—The federal government has appropriated $1,000 for the installation of ornamental lamps for the new federal building. Four brackets of bronze, each carrying a cluster of five lamps, will be erected on the building.

SHELDON, IA.—The City Council is reported to be contemplating the establishment of a municipal light plant in connection with the water-works system or granting a new franchise to the Sheldon Electric Light Company with the privilege of purchasing the property at the end of any five-year period. The franchise of the Sheldon company has expired.

SHENANDOAH, IA.—The City Council has awarded the Artificial Ice, Power, Heat & Light Company a contract for lighting the streets of the city. The contract calls for the installation of 165 tungsten lamps of 100 cp in the residence district and twenty arc lamps in the business section.

SIGOURNEY, IA.—R. L. Van Meter, of Cedar Rapids, Ia., has purchased an interest in the local electric-light plant, which was owned and operated by J. F. Bray, of Sigourney. It is said that improvements will be made to the plant.

STACYVILLE, IA.—The Eureka Telephone Company has sold its local telephone exchange to Peter Halbeck for a consideration of $15,000. It is reported that improvements will be made to the property.

BEATTIE, KAN.—The City Council has granted a franchise to Harry D. Hockman to establish and operate an electric-light, heat and power plant for a term of twenty years. Under the terms of the franchise the plant must be completed within four months.

BLUE RAPIDS, KAN.—The Yurann Development Company, which recently filed articles of incorporation under the laws of the State of Maine, contemplates the development of the water-power, gypsum deposits, etc., in or near Blue Rapids. The charter of the company specifies that electricity generated at the falls of the Blue River shall not be transmitted more than 40 miles from Blue Rapids. The company is capitalized at $1,000,000. Clarence E. Eaton is president, T. L. Croteau treasurer and James E. Manter clerk, all of Portland, Maine.

LAWRENCE, KAN.—The contract for the electric wiring of the county poor farm has been awarded to the Lawrence Railway & Light Company, at $1,800. The company has also agreed to supply electrical service at the farm at 10 per cent below the commercial rate.

DONALDSONVILLE, LA.—The Town Council has engaged George M. Forde, consulting engineer, to prepare plans for improvements to the municipal electric-light plant and waterworks system. The cost of the work is estimated at about $30,000.

GALVEZ, LA.—It is reported that bonds have been voted for the construction of a municipal electric-light plant in Galvez.

NEW ORLEANS, LA.—Plans are under consideration by New York and European capitalists for the development of the hydroelectric resources of Louisiana to furnish electrical energy for an electric transmission line, 150 miles in length, and a system of electric interurban railways, through the central, western and southwestern parts of Louisiana, which will involve an expenditure of from $10,000,000 to $25,000,000. The ultimate aim of the project is to transmit and distribute electrical energy for lamps and motors in New Orleans on a basis of from 8 to 10 cents per kw-hour. It is said that investigations have been made in connection with this project by Henry Floy, 165 Broadway, New York, N. Y., consulting engineer.

VIVIAN, LA.—The Caldwell & Heath Electric Company, it is stated, is contemplating the construction of a power house, work on which will begin in the near future.

CLINTON, MASS.—Plans are being considered by the Selectmen for changes in the present street-lighting system. The Clinton Gas & Electric Company has agreed to replace the arc lamps now in use with tungsten lamps. Under the terms of the contract four tungsten lamps are to be installed for every arc lamp taken out. The company also agrees to replace the 32-cp incandescent lamps with 40-cp lamps.

NORTH EGREMONT, MASS.—The Great Barrington Electric Light Company is reported to be contemplating extending its electric transmission lines from South Egremont up Egremont to this village to supply electricity for lamps.

BATTLE CREEK, MICH.—Preparations are being made by the Commonwealth Power Company for the erection of a new power plant in Battle Creek, to cost approximately $250,000, work on which will begin at once. The proposed power house will be the terminal of a high-tension transmission line extending from the company's plant on the Ausable River to this city, a distance of about 250 miles. The new power house will be located on the Elm Street extension and the present plant in the city will be torn down as soon as the machinery is removed to the new plant. The Battle Creek plant will supply the feed wires to Kalamazoo, Jackson, Lansing, Sturgis and Ceresco.

GLADWIN, MICH.—The plant and holdings of the local electric-light plant, owned by Schulz & Prindle, have been purchased by the Consolidated Light & Power Company, of Detroit, Mich., for a consideration of $18,000.

GRAND RAPIDS, MICH.—Plans have been submitted to the City Council for the installation of a boulevard system of lighting on Canal, Monroe and Division Streets, the cost to be paid by the property owners.

GRAND RAPIDS, MICH.—Bids will be received by the Board of Public Works until Jan. 25 for a 350-hp to 375-hp water-tube boiler for the municipal electric-light plant. Samuel A. Freshney is secretary of the board.

LANSING, MICH.—It is reported that the Central Traction Company, recently organized with a capital stock of $100,000, will lease the property of the Michigan United Railways Company. The last-named company, it is said, has for some time been negotiating for capital to build additional interurban railways.

MUSKEGON, MICH.—Preparations are being made by the Grand Rapids-Muskegon Power Company for the installation of a distributing system for supplying electricity for street lighting and for commercial purposes and the erection of a transmission line from the Croton dam to Muskegon, 44 miles long. The company was recently awarded the contract for street lighting, the service to begin July 1, 1912. The contract provides for groups of five 40-cp tungsten lamps, to be furnished at $52.50 per year per group unit; arc lamps at $57.50 each per year, and incandescent lamps at $16 per lamp per year.

SPARTA, MICH.—The Sparta Milling Company will rebuild its plant, which was recently destroyed by fire. It is understood that material for the plant has already been purchased. The company supplied electrical service in Sparta.

CLARA CITY, MINN.—It is reported that a franchise has been granted for the installation of an electric-light plant in Clara City to Charles Bush and E. Behrends.

LINDSTROM, MINN.—The St. Croix Falls Minnesota Improvement Company, it is reported, is planning to erect a substation in Lindstrom.

MINNEAPOLIS, MINN.—The City Council has adopted a resolution authorizing the Minneapolis Street Railway Company to build before Oct. 1 a double-track continuous line over the following route: Connecting with the Hennepin Avenue lines on Eleventh Street to connect with the lines on Fourth Avenue, south to Franklin Avenue, across the Mississippi River, on Mississippi Street, across River Road on Hamline, Arthur and Sheran Avenues to the east city limits.

TWO HARBORS, MINN.—The Great Northern Power Company, of Duluth, Minn., has submitted a proposition to the City Council offering to supply electricity to operate the municipal electric-light system at 1½ cents per kw-hour. It is proposed to supply energy from the company's plant at Duluth, extending its transmission lines from Lakeside. Bids have been received by the city for the installation of a new unit at the electric plant. These are being held up temporarily to give an opportunity to look into the offer of the Great Northern Power Company. Joseph B. Crane, of Duluth, Minn., is contract agent of the power company.

ELMO, MO.—The installation of an electric-light plant in Elmo is reported to be under consideration. The cost of the plant is estimated at about $4,000.

KANSAS CITY MO.—Sealed proposals will be received by the Board of Public Works, City Hall, Kansas City, Mo., until Jan. 9, 1912, for furnishing and installing one 265-hp steam engine and one 175-kw, 120-volt direct-current generator, direct-connected, in the engine-room of the city hall. Specifications can be obtained on application to E. E. Purcell, secretary board of public works.

TUCUMCARI, N. M.—The Tucumcari Light & Power Company is reported to have adopted plans for a new power plant to be installed in Tucumcari.

ALBANY, N. Y.—The Public Service Commission, Second District, has issued an opinion authorizing the Hudson River & Eastern Traction Company to construct an electric railway from Ossining to White Plains, in Westchester County, by bonds alone.

BROOKLYN, N. Y.—Bids will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until Jan. 23, 1912, for furnishing at the navy yard, Brooklyn, N. Y., the following supplies: Schedule 4238—miscellaneous distribution boxes, etc., steel conduit, brass conduit fittings, steel conduit fittings, 1800 interior fittings, insulator hangers, 150 watertight jacks, attachment plugs, rubber rings and sockets, two-arm semaphores, lamp sockets, etc., switches and receptacles, unions, malleable-iron conduit unions, single-conductor wire; schedule 4230—30,000 ft. incandescent lamp cord, 60-cycle fans, and lead-covered wire; schedule 4239—brass lamp feeders. Applications for proposals should designate the schedule desired by number, which can be obtained at the above bureau or at the navy pay office nearest each navy yard. T. J. Cowie is paymaster-general, U. S. N.

COOPERSTOWN, N. Y.—The plant and holdings of the Clinton Mills Power Company, which supplies electrical service in Cooperstown and operates the local gas plant, has been purchased by the Otsego & Herkimer Railroad Company, of Oneonta, which will take possession immediately.

GLOVERSVILLE, N. Y.—Plans are being considered by the Fulton County Gas & Electric Company for the installation of a new street-lighting system in Gloversville. Luminous-arc lamps will be erected in the business section and incandescent lamps in the residential district. It is expected to have the new lamps installed by March 1.

LOWVILLE, N. Y.—O. B. Phillips, of Lowville, is reported to have secured an option on Eagle Falls on Beaver River, about 3 miles from Number Four, which he proposes to develop to generate electricity. It is estimated that from 2500 hp to 3000 hp can be developed with a head of 100 ft.

PERRY, N. Y.—The installation of a municipal electric-light plant in Perry is under consideration. The cost of the proposed plant is estimated at about $15,000.

ROCHESTER, N. Y.—The Rochester Railway, Light & Power Company is considering the question of extending its transmission lines into the country districts surrounding Rochester, with a view of supplying the farmers with electricity for lamps and motors.

SARATOGA, N. Y.—The Adirondack Electric Power Company of Saratoga, which recently filed articles of incorporation with the Secretary of State, has applied to the Public Service Commission, Second District, for approval of its issue of $12,000,000 in capital stock and bonds to the amount of $5,000,000. The company proposes to take over the properties of the Hudson River Water Power Company and seven other companies operating in Warren, Saratoga, Washington, Rensselaer, Albany, Schenectady, Schoharie, Montgomery, Fulton, Herkimer, Oneida and Madison Counties. The present plan calls for the use of about $4,200,000 in cash for the payments of the underlying issues, $500,000 for new construction, $500,000 for new working capital and about $140,000 for various payments of underlying liens. The officers of the company are: James R. Hooper, of Boston, Mass., president; Charles E. Willock, of Pittsburgh, Pa., vice-president; Francis M. Edwards, of Boston, Mass., secretary, and William H. Blood, Jr., of Boston, Mass., treasurer. The Stone & Webster Management Association Corporation, of Boston, Mass., will operate the properties.

SEA CLIFF, N. Y.—The Glen Cove Light & Power Company has applied to the Village Board for a franchise to supply electricity in Sea Cliff for a period of twenty-five years. The company agrees to supply electricity at the rate of 9 cents per kw-hour. The Nassau Light & Power Company, of Mineola, now supplies electrical service and charges consumers 15 cents per kw-hour.

DURHAM, N. C.—It is reported that arrangements are being made to connect the lighting system of Trinity College with the wires of the Southern Power Company to supply electricity for the lamps on the campus, which is now supplied by the central heating and lighting plant in Crowell Science Hall.

GOLDSBORO, N. C.—The Goldsboro, Seven Springs & Swansboro Railroad Company, recently chartered, has purchased the property and franchises of the Goldsboro Traction Company. The new company is said to be preparing plans for an immediate extension of the railway from Goldsboro to Seven Springs. The extension to Swansboro, a distance of 60 miles or more, will not be started before next fall.

MAIDEN, N. C.—Plans are being considered for the installation of an electric-light system in Maiden. For further information address O. F. Asbury, of the American Machine & Manufacturing Company, of Charlotte, N. C.

WILMINGTON, N. C.—Plans are being considered by the Tidewater Power Company, which owns and operates the city and interurban electric railways, electric and gas plants in Wilmington, for improvements and extensions to its system, which will involve an expenditure of about $125,000. Work will begin on the proposed work about Feb. 1, 1912.

AKRON, OHIO.—The Goodyear Tire & Rubber Company has been given a permit to erect an electric-light plant. The equipment of the plant will include a 1500-kw, 500-volt generator and a 500-kw motor generator set. The lighting system will provide for 1200 tungsten lamps. Work will begin at once on construction of the proposed plant.

CARTHAGE, OHIO.—Sealed proposals will be received at the office of Elzner & Anderson, 136 Ingalls Building, Cleveland, Ohio, until Jan. 25 for electric work on the new amusement hall on the ground of the Longview Hospital at Carthage.

FOSTORIA, OHIO.—Application has been made to the City Council by Harry W. Lloyd, attorney, of Toledo, Ohio, representing Albert B. Osborn, of Indianapolis, Ind., for two franchises in Fostoria, for a period of forty years. One is for the erection of a transmission line for the distribution of electricity for lamps, heat and motors and the other for laying pipes for a steam or hot-water plant.

GREENVILLE, OHIO.—The Greenville Electric Light & Power Company has applied to the Ohio Public Service Commission for authority to issue $25,000 in capital stock, to be sold at par, the proceeds to be used for improvements and extensions to its system.

HAMILTON, OHIO.—The Ohio Electric Railway Company is contemplating extending its local service. The first improvement will be an extension over Prospect Hill, for which local residents are raising a loan of $12,000.

MOUNT CORY, OHIO.—The Village Council has passed an ordinance providing for a bond issue to establish a lighting system in Mount Cory, energy for same to be purchased from the Western Ohio Railway Company. All persons owning property have been asked to install large electric lamps upon their front porches; electricity for these lamps will be supplied free of charge by the village.

NEW MADISON, OHIO.—Application has been made to the New Madison Lighting Company for permission to issue $3,500 in capital stock, the proceeds to be used for improvements to its plant.

HAMMON, OKLA.—At an election held Dec. 20 bonds to the amount of $21,000 were voted, of which the proceeds of $3,500 will be used for the installation of an electric-light system. The remainder will be used for water-works. Bids will be received until Jan. 11 for bonds and construction. The Western Engineering Company, of Oklahoma City, Okla., has charge of the engineering work.

HOLDENVILLE, OKLA.—A report has been submitted to the City Commissioners by the consulting engineers for extensions to the water-works system, which include the installation of an electric plant to provide electricity for lighting the city and for pumping water. The cost of the proposed improvements is estimated at $34,000.

MULDROW, OKLA.—It is reported that the Town Trustees are negotiating with the Fort Smith Light & Traction Company, of Fort Smith, Ark., to extend its transmission lines to Muldrow and supply electricity for commercial purposes. Bonds have been voted for the installation of a municipal electric-light plant and water-works system.

COTTAGE GROVE, ORE.—Plans are being prepared by O. J. Young, of Ashland, and associates for the installation of an electric-smelting plant at Cottage Grove.

ELGIN, ORE.—The City Council has granted the Elgin Light & Power Company a new franchise for a period of forty-five years. Among the concessions given by the company is the furnishing of electricity to light the Council Chamber and the jail and for fire alarms free of charge.

McMINVILLE, ORE.—Bonds to the amount of $75,000 have been voted for public improvements, of which about $30,000 will be expended for improvements to water and light systems and $15,000 for water mains and the remainder for street improvements.

PORTLAND, ORE.—The stockholders of the Pacific Power & Light Company at a special meeting held recently in Augusta, Maine, approved of an increase in capital stock of from $7,500,000 to $12,000,000.

PORTLAND, ORE.—The Portland Railway, Light & Power Company is reported to have appropriated $1,500,000 for extensions and improvements to its system in 1912. A new substation is to be erected on the west side of the city, to cost $100,000, and new line construction, underground and overhead, to cost approximately $1,000,000. Improvements will also be made to the interurban electric system.

PRINEVILLE, ORE.—The Prineville & Eastern Railway Company has been granted a franchise to build an electric railway in Prineville.

WOODBURN, ORE.—The Portland Railway, Light & Power Company is contemplating the installation of a new incandescent street-lighting system in Woodburn to replace the arc lamps now in use.

ALLENTOWN, PA.—The installation of ornamental street lamps on Hamilton Street, from Fifth to Ninth, is under consideration.

ALTOONA, PA.—The Altoona & Logan Valley Electric Railway Company is contemplating the construction of an addition to its power plant, located at Fifth Avenue and Thirty-second Street, in the near future.

CORRY, PA.—The Corry Brick & Tile Company has awarded a contract to the C. R. Rogers Company for the installation of an electric-light plant at its works to supply electricity for lighting same.

PITTSBURGH, PA.—The City Council has granted the Pennsylvania Light, Heat & Power Company the right to extend its service to the twenty wards of the old city. The company now operates exclusively on the North Side. The franchise is for a period of fifty years, but the city has the option of purchasing the plant and equipment of the company after twenty-five years, upon payment of the actual cost of construcion, less depreciation, plus 15 per cent, without any consideration or allowance for franchise value or earning power. The company agrees to furnish electricity for lamps at a price not exceeding 8 cents per kw-hour and to furnish arc lamps to the city, the price not to exceed $65 each per year. The company also agrees to pay the city 2½ per cent of its gross receipts and to furnish all consumers with meters without additional charge.

PITTSBURGH, PA.—The Allegheny County Light Company has submitted a proposition to the City Council, whereby in consideration of a ten-year contract street lamps will be furnished for considerably less than the city is now paying. J. D. Callery, president of the Allegheny County Lighting Company, stated that extensive improvements and additions are contemplated to the present power plant, and if a long-term contract for street-lighting was secured the company might either buy or lease the present municipal lighting plant which suppiles electricity for street lighting on the North Side, or what was formerly the city of Allegheny. The Allegheny company now supplies electricity for lighting a portion of the city and hopes by the above offer to secure a contract for furnishing street lamps for the entire city.

WASHINGTON, PA.—The West Penn Electric Company has taken over the plant and holdings of the Centerville Electric Company, which supplies electrical service in the Centreville borough district, and also the property of the Union Township Electric Company, which supplies electricity for lamps, heat and motors in Union Township. Both places are located in Washington County.

AIKEN, S. C.—The dam and power plant of the Carolina Light & Power Company at Langley, S. C., was carried away by flood recently, causing a loss of about $35,000. At present the auxiliary plant at Horse Creek is furnishing the service.

LEMMON, S. D.—The Council is reported to have granted the Lemmon Electric Light & Power Company a franchise to construct and operate an electric-light plant in Lemmon.

IRON CITY, TENN.—The plant and holdings of the Blue Bell Telephone Company, with exchanges at Iron City and West Point, have been acquired by the Cumberland Telephone Company. Improvements will be made to the system.

NASHVILLE, TENN.—Plans are being prepared by the Great Falls Power Company, of Nashville, Tenn., for a hydroelectric power development along the Caney Fork River, a short distance from Nashville. It is understood that work will soon begin on the construction of a large hydroelectric power plant. Electricity generated by the plant will be transmitted to Nashville and neighboring cities in Tennessee. F. H. Yost is superintendent of the company.

COLLINSVILLE, TEX.—Plans are being prepared by the Collinsville Mill & Elevator Company, it is reported, for the installation of an electric-light plant and water-works system in Collinsville.

CORPUS CHRISTI, TEX.—The Corpus Christi Street & Interurban Railway Company has been granted a franchise by the City Council for an extension of its railway in the South Bluff portion of the city. The proposed extension will be 2 miles long.

EBENEZER, TEX.—The Alamo Land & Sugar Company is planning to build an interurban loop railway through its 32,000-acre tract of land near here. It also proposes to construct a large irrigation system, including pumping plant and distributing canals and ditches. The plans also embrace the establishment of a new town upon the tract of land. Ebenezer has not a post office.

GREENVILLE, TEX.—The plans of the East Texas Traction Company for the construction of an interurban electric railway from Greenville to Paris and thence to Clarksville provide for the construction of a large power plant in Greenville, to cost approximately $400,000. Surveys for the proposed railway have been made by the Mansfield Engineering Company of Indiana. The proposed railway will be about 193 miles long. Joseph F. Nichols, of Greenville, is interested in the project.

MINEOLA, TEX.—It is reported that plans are being considered by the Mineola Light, Ice & Water Company for the installation of additional equipment, including lighting apparatus. A twenty-four-hour service will be established as soon as improvements are completed. A. S. Cochrane is president of the company.

PORT ARANSAS, TEX.—It is reported that New York parties contemplate asking for a franchise to build and operate an electric-light plant and ice factory in Port Aransas.

RIVIERA, TEX.—Plans are being considered by Theodore F. Koch, of Riviera, for the construction of an electric interurban railway between Riviera and Riviera Beach, a distance of about 10 miles.

BURLINGTON, VT.—The Burlington Light & Power Company is contemplating developing the water-power on the Winooski River at Hubbel's Falls in Essex. The storage dam will extend about 2½ miles up the river. It is estimated that 3000 hp can be developed.

WILDER, VT.—It is reported that the International Paper Company is contemplating the development of an important water-power at its Wilder plant, which will involve an expenditure of about $350,000. The power will be used to generate electricity to operate its plant. The surplus will be sold to manufacturing plants in and around Wilder.

HAMILTON, VA.—The Town Council is reported to have granted E. A. Cockey, Jr., a franchise to construct and operate an electric-light system in Hamilton. Mr. Cockey also has franchises to supply electricity for lamps in Purcellville and Round Hill.

LAWRENCEVILLE, VA.—It is reported that bonds to the amount of $50,000 have been voted, the proceeds to be used for the installation of an electric-light plant, sewerage and water-works systems.

NEWPORT NEWS, VA.—The City Council is reported to have appointed a special committee to make investigations as to the advisability of the installation of a new street-lighting system.

NORFOLK, VA.—Sealed proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until Jan. 27 for two electrically driven capstans for the navy yard, Norfolk, Va. Specifications can be obtained on application to the above bureau or to the commandant of the navy yard named. The cost of the work is estimated at about $6,000. R. C. Hollyday is chief of the bureau.

DAYTON, WASH.—The Pacific Power & Light Company has applied to the County Commissioners for a franchise to supply electricity for lamps and motors throughout Columbus County.

IRONDALE, WASH.—The Olympic Power Company is planning to erect a new transmission line between Irondale and Bremerton, a distance of about 40 miles, work on which will soon begin.

MOXEE CITY, WASH.—The Pacific Power & Light Company has been granted a franchise to install an electric-lighting system in Moxee City. Electricity for operating the system will be secured from the company's high-tension transmission line between North Yakima and Priest Rapids.

SEATTLE, WASH.—The Oregon-Washington Railroad & Navigation Company has submitted plans for approval to the Seattle superintendent of buildings for the erection of a power plant in connection with its new repair shops at Argo.

INNISFAIL, ALTA., CAN.—The Town Council has engaged Mr. Maxwell as consulting and supervising engineer in connection with the installation of an electric-light system for the town. Work on the proposed plant will not begin until spring.

FERNIE, B. C., CAN.—It is reported that the plant of the Bull River Power Company has been taken over by a syndicate in which M. A. Devitt and H. W. McCoy are interested. The new company, it is said, will erect a duplicate transmission line on steel towers direct to Fernie and continue it on through the Crow's Nest Pass to Frank. The original plans were for an immediate development of 10,000 hp, which will probably be carried out.

CHATHAM, ONT., CAN.—It is reported that plans are being considered for replacing the present street arc lamps with a more modern type early this year.

FOREST, ONT., CAN.—A by-law, it is reported, will soon be submitted to the ratepayers to purchase the electric-light plant, to be owned and operated by the municipality.

HAMILTON, ONT., CAN.—The City Council will make an effort to secure legislation to force all companies using overhead wires to place their wires underground. It is proposed to have all wires placed in one conduit.

KINCARDINE, ONT., CAN.—The Board of Electric Light Commissioners is reported to be considering the question of extending the municipal lighting system.

LONDON, ONT., CAN.—It is reported that plans are being considered by the commissioners for extensions to the street-lighting system. It is proposed to add about 500 lamps during the coming year.

OTTAWA, ONT., CAN.—The Ottawa Light, Heat & Power Company, it is said, is planning to increase the output of its steam auxiliary plant.

ROULEAU, SASK., CAN.—The by-law to appropriate $15,000 to complete the electric-light system is reported to have been carried.

New Industrial Companies.

THE SOLAR INVERTED ARC LAMP COMPANY OF ILLINOIS, of Chicago, Ill., has been incorporated by David Broutman, Isadore S. Krinsky and Samuel Solomon. The company is capitalized at $10,000 and proposes to manufacture and deal in electric and gas fixtures and appliances.

THE UNION ELECTRICAL SUPPLY COMPANY, of Providence R. I., has been incorporated with a capital stock of $50,000 for the purpose of dealing in electrical supplies and doing general electrical work. The incorporators are: William L. Adams, Mervyn F. Folk and John A. Tillinghast, all of Providence, R. I.

THE UNITED STATES GAS & ELECTRIC SIGN COMPANY, of Chicago, Ill., has filed articles of incorporation with a capital stock of $15,000 to manufacture and deal in gas, electric signs and specialties. The incorporators are: John Stelk, Nels H. Olsen and Frank Bicek.

New Incorporations.

SAN FRANCISCO, CAL.—The California-Oregon Power Company has been incorporated with a capital stock of $10,000,000 for the purpose of operating in the northern part of California and the southern part of Oregon. The incorporators are: A. L. Whittle, of Mill Valley; F. B. Lorigan and E. Schwab, of San Francisco, Cal.

SAN FRANCISCO, CAL.—The Northern Power & Water Company has filed articles of incorporation with a capital stock of $25,000,000 for the purpose of dealing in power and water. The incorporators are: F. E. Boland, C. W. Willard, H. L. Atkinson, J. B. McKeon, T. A. Allen, J. F. Cassell, P. J. Muller, A. C. Greene, all of San Francisco, Cal., and S. J. Langmaid, of Berkeley, Cal.

BOISE, IDAHO.—Articles of incorporation have been filed for the Southern Idaho Light, Heat & Power Company at Boise, Idaho, with a capital stock of $20,000,000. William Mainland, Oshkosh, Wis., is president of the company and O. G. F. Markhus, of Boise, agent.

BUCKLEY, ILL.—The Buckley Telephone Company has been incorporated with a capital stock of $20,000 by Harry S. Boscart, Elwin Hall, Frank E. Singleton and William S. Hale.

DECATUR, ILL.—Articles of incorporation have been filed for the Decatur-Pana Southern Railway Company, with a capital stock of $25,000, to construct and operate a railway from Decatur to Pana, Ill. The incorporators are: H. S. Ashcraft, John H. Martin, J. W. Lockett and Peter Charles, of Decatur, Ill.

Trade Publications.

OZONATORS.—In Bulletin No. 4912, recently issued by the General Electric Company, is a collection of several articles devoted to the use of apparatus for air purification. Various applications of the apparatus are illustrated.

PLANERS.—A catalog on this subject has been issued by Joseph T. Ryerson & Son, Chicago. In it are described the Rockford heavy-duty, variable-speed and motor-drive planers. A general outline of the Rockford planer prefaces the specifications of the various units.

BALL BEARINGS.—The S. K. F. Ball Bearing Company, New York, has issued a bulletin on its radial bearings, explaining the peculiarities of construction, particularly the provision for self-alignment, and giving dimensions, speeds and capacities of the principal types and sizes.

STEAM-PIPE CASINGS.—Waterproof wood casings provide simple, durable and efficient means for insulating underground steam pipes, and the Michigan Pipe Company, Bay City, Mich., has published a small catalog giving details, prices, dimensions, etc., of its product for this service.

DOUBLE-ACTING TRIPLEX PISTON PUMPS.—Bulletin No. 104, issued by the Goulds Manufacturing Company, Seneca Falls, N. Y., contains specifications, dimensions, capacities and illustrations of its double-acting triplex pumps. These are built for working pressures as high as 150 lb.

OIL ENGINES.—The Remington Oil Engine Company, Stamford, Conn., has issued an illustrated folder devoted to its marine and stationary oil engines. Various applications are illustrated, such as pumping, hoisting, electric lighting, compressing air, general manufacturing, milling, refrigeration, etc.

CALENDAR.—A very attractive wall calendar for 1912 has been issued by the American District Steam Company, of North Tonawanda, N. Y. Besides the usual monthly calendar there is a beautiful reproduction of Wakefield, Va., the birthplace of Washington, from the painting by M. H. Lowell. To the back of the calendar is attached a separate sheet containing the history of Wakefield and a short biography of the painter.

Business Notes.

THE INDEPENDENT ELECTRIC MANUFACTURING COMPANY, MILWAUKEE, WIS., will be represented by the Western Sales Company in Denver, Col. A complete line of electric motor starters and controllers will be carried in stock.

ISBELL ELECTRICAL COMPANY.—Will H. Isbell has purchased the electrical business of J. W. Chapman in Bowling Green, Ky., and

will hereafter conduct the establishment upon an enlarged and improved plan under the name of the Isbell Electrical Company.

FIRE IN ELECTROSE WORKS.—Owing to a fire in its works, the Electrose Manufacturing Company has opened a temporary office at 109 Broadway, Brooklyn, N. Y. Considerable damage was done to the plant, but it will be ready for resuming work by Feb. 15, and possibly earlier. Advantage is being taken of the occasion to enlarge the plant by 50 per cent.

PRINTOMETERS FOR CHICAGO SANITARY DISTRICT.—On the recommendation of its electrical engineer, the Sanitary District of Chicago has authorized the purchase from the Minerallac Electric Company of ten printometers and ten contact-making clocks to be installed in each of the ten city substations to measure the energy used by the city for street lighting and furnished by the Sanitary District. Each printometer is to cost $106.40 and each contact-making clock $21, making $127.40 for each set, or $1,247 for the ten.

AMERICAN ENGINEERING COMPANY.—Announcement is made of the consolidation of Williamson Brothers Company, of Philadelphia, and the American Ship Windlass Company and Taylor Stoker Company, formerly of Providence, R. I., under the title "American Engineering Company," with works and executive offices at Philadelphia, Pa. The Taylor stoker was originally built in the plant at Providence, but both the marine and stoker business at this plant grew to such an extent that it became necessary to transfer the marine business to Philadelphia in order to give more room for stoker work, which very soon, however, began to outgrow the Providence plant. As it was impracticable to increase the capacity of this plant without entirely rebuilding, the decision was made to build additional shops at Philadelphia and consolidate all the various departments of the business under one head at that point.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

ALABAMA LIGHT & TRACTION ASSOCIATION. Secretary, Geo. S. Emery, 11 N. Royal St., Mobile, Ala.

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, Prof. J. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. J. Willard Travell, 27 East 11th St., New York.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS. Secretary-Treasurer, Eugene W. Stern, 103 Park Ave., New York City. The Council meets the first Friday of every month. Next annual meeting, Jan. 16, 1912, New York, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Honorary secretary, Ralph W. Pope; acting secretary, F. L. Hutchinson. Engineering Societies Building, 29 West 39th St., New York. Meetings, second Friday of each month, excepting June, July, August and September.

AMERICAN ELECTRIC RAILWAY ACCOUNTANTS' ASSOCIATION. Secretary, H. E. Weeks, Davenport, Ia.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION. Secretary, Norman Litchfield, Interborough Rapid Transit Company, New York.

AMERICAN ELECTRIC RAILWAY ASSOCIATION. Secretary, H. C. Donecker, Engineering Societies Building, 29 West 39th St., New York.

AMERICAN PHYSICAL SOCIETY. Secretary, Ernest Merritt, Cornell University, Ithaca, N. Y.

ARKANSAS ASSOCIATION OF PUBLIC UTILITIES OPERATORS. Secretary, E. H. Hardin, Hot Springs, Ark.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS. Secretary, James Farrington, Steubenville, Ohio.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Secretary, P. W. Drew, 135 Adams St., Chicago.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS. Secretary, J. Andreucetti, Chicago & Northwestern Railway, Chicago.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, H. T. Edgar, Seattle, Wash.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Secretary, F. D. Morris, 323 Hagerman Building, Colorado Springs, Col.

ELECTRIC CLUB, CHICAGO. Secretary, N. E. Obright, 1500 American Trust Bldg., Chicago. Meets every Wednesday noon, 303 Wabash Ave.

ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, Geo. W. Russell, Jr., 25 West 42d St., New York. Next annual meeting, Jan. 16, 1912, New York, N. Y.

ELECTRICAL CONTRACTORS' ASSOCIATION OF STATE OF MISSOURI. Secretary, Ernest S. Cowie, 1413 Grand Ave., Kansas City, Mo.

ELECTRICAL SALESMEN'S ASSOCIATION. Secretary, Francis Raymond, 125 Michigan Ave., Chicago. Annual meeting, Chicago, January each year.

ELECTRICAL TRADES ASSOCIATION OF CANADA. Secretary, William R. Staveley, Royal Insurance Building, Montreal, Can.

ELECTRICAL CREDIT ASSOCIATION OF CHICAGO. Secretary, Frederic P. Vose, Marquette Building, Chicago.

ELECTRICAL TRADES ASSOCIATION OF THE PACIFIC COAST. Secretary, Albert H. Elliott, Harding Building, 34 Ellis St., San Francisco, Cal. Monthly meeting, San Francisco, second Thursday of each month.

ELECTRIC VEHICLE ASSOCIATION OF AMERICA. Assistant Secretary, Harvey Robinson, 245 West 42d St., New York. Meetings, fourth Tuesday of each month.

ELECTRICAL TRADES SOCIETY OF NEW YORK (Member National Electrical Credit Association). Secretary, Franz Neilson, 80 Wall St., New York. Board of Directors meets second Thursday of each month.

ELECTRIC TRADES ASSOCIATION OF PHILADELPHIA. Secretary, J. W. Crum, 1324 Land Title Building, Philadelphia, Pa. Meetings, second and fourth Thursday of each month.

EMPIRE STATE GAS & ELECTRIC ASSOCIATION. Secretary, Charles H. B. Chapin, Engineering Societies Building, 29 West 39th St., New York.

FLORIDA ELECTRIC LIGHT & POWER ASSOCIATION. Secretary, H. C. Adams, West Palm Beach, Fla.

GAS, ELECTRIC & RAILWAY ASSOCIATION OF OKLAHOMA. Secretary, H. V. Bozell, Norman, Okla.

ILLINOIS STATE ELECTRICAL ASSOCIATION. Secretary, H. E. Chubbuck, Peoria, Ill.

ILLUMINATING ENGINEERING SOCIETY. Secretary, P. S. Millar, Engineering Societies Building, 29 West 39th St., New York. Sections in New York, New England, Philadelphia and Chicago.

INDEPENDENT ELECTRICAL CONTRACTORS' ASSOCIATION OF GREATER NEW YORK. Secretary, L. H. Woods, 2355 Jerome Ave., New York.

INDIANA ELECTRIC LIGHT ASSOCIATION. Secretary, J. V. Zartman, Indianapolis, Ind.

INTERNAL COMBUSTION ENGINE ASSOCIATION. Secretary, Chas. Kratch, 416 W. Indiana St., Chicago. Meetings, second Friday of each month.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, C. R. George, Houston, Tex.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (international body representing various national electrical engineering societies contributing to its support). Secretary, C. le Maistre, 28 Victoria St., Westminster, London, S. W., England. Next meeting at Berlin in 1913.

IOWA ELECTRICAL ASSOCIATION. Secretary, A. W. Zahm, Mason City, Ia.

IOWA STREET & INTERURBAN RAILWAY ASSOCIATION. Secretary, H. E. Weeks, Davenport, Ia.

KANSAS GAS, WATER & ELECTRIC LIGHT ASSOCIATION. Secretary, James D. Nicholson, Newton, Kan.

LOUISIANA ELECTRICAL ASSOCIATION. Secretary, W. H. Bower Spangenberg, 627 Poydras St., New Orleans, La. Meets third Monday of each month.

MAINE ELECTRICAL ASSOCIATION. Secretary, Walter S. Hyman, Waterville, Maine.

MICHIGAN ELECTRICAL ASSOCIATION. Secretary, Herbert Silvester, 18 Washington Boulevard, Detroit, Mich.

MINNESOTA ELECTRICAL ASSOCIATION. Secretary, T. C. Gordon, Little Falls, Minn.

MISSOURI ELECTRIC, GAS, STREET RAILWAY & WATER ASSOCIATION. Secretary, N. J. Cunningham, Springfield Gas & Electric Co., Springfield, Mo.

NATIONAL ARM, PIN & BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind.

NATIONAL DISTRICT HEATING ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio. Next annual convention at Detroit, June 25-27, 1912.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 41 Martin Building, Utica, N. Y. Next annual convention, July 17-19, 1912, Denver, Col.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Executive secretary, T. C. Martin, Engineering Societies Building, 33 West 39th St., New York. Next annual convention at Seattle, Wash., June 9-15, 1912.

NATIONAL ELECTRIC LIGHT ASSOCIATION, CANADIAN SECTION. Secretary, T. S. Young, 220 King St. West, Toronto, Can.

NATIONAL ELECTRIC LIGHT ASSOCIATION, GEORGIA SECTION. Secretary-treasurer, T. W. Peters, Columbus Railway Company, Columbus, Ga.

NATIONAL ELECTRIC LIGHT ASSOCIATION, MISSISSIPPI SECTION. Secretary, A. H. Jones, McComb City, Miss.

NATIONAL ELECTRIC LIGHT ASSOCIATION, NEBRASKA SECTION. Secretary-Treasurer, S. J. Bell, David City, Neb.

NATIONAL ELECTRIC LIGHT ASSOCIATION, NEW ENGLAND SECTION. Secretary, Miss O. A. Bursiel, 149 Tremont St., Boston, Mass. Next annual convention, Springfield, Mass., March 14 and 15, 1912.

NATIONAL ELECTRIC LIGHT ASSOCIATION, PENNSYLVANIA SECTION. Secretary-treasurer, W. E. Long, Philadelphia, Pa.

NATIONAL ELECTRIC INSPECTORS' ASSOCIATION. Secretary, T. H. Day, 27 Pliny St., Hartford, Conn.

NATIONAL ELECTRICAL CREDIT ASSOCIATION. Secretary, Frederick P. Vose, 1343 Marquette Bldg., Chicago.

NATIONAL FIRE PROTECTION ASSOCIATION. Secretary, R. Sweetland, 141 Milk St., Boston, Mass. Next biennial meeting, March, 1913.

NATIONAL INDEPENDENT TELEPHONE ASSOCIATION. Secretary, Joseph B. Ware, Grand Rapids, Mich. Next annual convention, Feb. 7-9, 1912, Chicago, Ill.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, John J. Lane, 12 Pearl St., Boston, Mass. Meets last Thursday of each month.

NEW ENGLAND ELECTRICAL TRADES ASSOCIATION. Secretary, Alton F. Tupper, 84 State St., Boston, Mass. Directors meet first Wednesday of each month.

NEW ORLEANS ELECTRICAL CONTRACTORS' ASSOCIATION. Secretary, L. G. Marks, 312 Carondelet St., New Orleans, La. Meetings, second and fourth Tuesday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, Engineering Societies Building, 33 West 39th St., New York.

NORTHWEST ELECTRIC LIGHT & POWER ASSOCIATION. Secretary, N. W. Brockett, Cataract Building, Seattle, Wash.

Ohio Electric Light Association. Secretary, D. L. Gaskill, Greenville, Ohio.

Ohio Society of Mechanical, Electrical & Steam Engineers. Secretary, Prof. I. E. Sanborn, Ohio State University, Columbus, Ohio.

Pittsburgh Electric Booster Club. Recording Wattmeter, O. R. Bombach, 919 Liberty Ave., Pittsburgh, Pa. Meetings, fourth Monday of each month.

Rejuvenated Sons of Jove. Jupiter, R. L. Jaynes, Pittsburgh, Pa.; Mercury (Secretary), E. C. Bennett, St. Louis, Mo.

Society for the Promotion of Engineering Education. Secretary, H. H. Norris, Cornell University, Ithaca, N. Y.

Society of Wireless Telegraph Engineers. Secretary, E. B. Moore, 39 Trinity Place, Boston, Mass. Monthly meeting, first Saturday of each month, at the Massachusetts Institute of Technology, Boston.

Southwestern Electrical & Gas Association. Secretary, D. G. Fisher, 1316 Commerce St., Dallas, Tex.

Street Railway Association of the State of New York. Secretary, J. C. Collins, Rochester, N. Y.

Vermont Electrical Association. Secretary-Treasurer, A. B. Marsden, Manchester, Vt.

Western Association of Electrical Inspectors. Secretary, W. S. Boyd, 76 West Monroe St., Chicago, Ill. Next annual meeting Jan. 23-25, 1912, Milwaukee, Wis.

Western Society of Engineers. Electrical Section, formerly Chicago Electrical Association. Secretary, J. H. Warder, 1737 Monadnock Block, Chicago. Regular meetings, first Friday of each month, except January, July and August. Annual meeting Tuesday after January 1 each year.

Wireless Institute. Secretary, Alfred N. Goldsmith, College of the City of New York, New York.

Wisconsin Electrical Association. Secretary, George Allison, Stephenson Building, Milwaukee, Wis. Next annual meeting, Milwaukee, January, 1912.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED DEC. 26, 1911.

[Prepared by Robert Starr Allyn, 16 Exchange Place, New York.]

1,012,590. ELECTRIC DOOR ALARM; C. F. Bobo, Brooklyn, N. Y. App. filed July 31, 1908. Portable burglar-alarm bell.

1,012,596. REGULATOR FOR HEATERS; A. Carpenter, Tacoma, Wash. App. filed Nov. 12, 1910. Temperature regulator for cookers.

1,012,599. PROTECTOR FOR POLYPHASE ELECTRICAL MACHINERY; J. G. Clemens, Buffalo, N. Y. App. filed Dec. 10, 1910. Panelboard switch, fuse and coil.

1,012,617. ELECTRIC RADIATOR; G. Egly, Treptow, Germany. App. filed July 18, 1911. Rod-and-tube improvement on Patent No. 994,447.

1,012,623. AUTOMATIC SIGNALING APPARATUS FOR ELEVATORS; A. A. Fuller, Birmingham, Ala. App. filed March 16, 1910. For signaling the approach of one of a battery of cars.

1,012,624. TANK-LEVEL SIGNAL; S. H. Gallagher, Carthage, N. Y. App. filed April 17, 1911. Float and switch system for gasoline, etc., tanks.

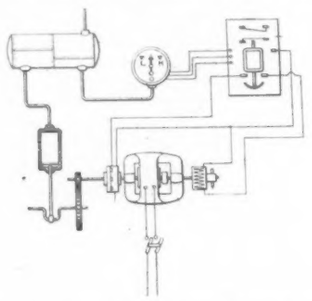
1,012,655. PROCESS FOR ELECTROPLATING WITH ZINC; A. A. Lemètre, Paris, France. App. filed May 29, 1911. $ZnSO_4$, NH_4Cl, $NaSO_4$, H_2SO_4 and water.

1,012,669. ELECTRIC-HEATING APPARATUS; H. Löfquist, Stockholm, Sweden. App. filed March 4, 1910. The heating element is surrounded with steatite for heating rooms, etc.

1,012,691. BURGLAR ALARM; A. Myers, Philadelphia, Pa. App. filed March 30, 1911. To be connected with the ordinary doorbell circuit.

1,012,699. TELEPHONE SYSTEM; A. F. Paige, Philadelphia, Pa. App. filed May 31, 1904. Special device for using an ordinary telephone circuit for automatic alarm, etc.

1,012,706. GAS FOR VAPOR ELECTRIC LAMP AND HEATER CONNECTED THEREWITH; H. N. Potter, New Rochelle, N. Y. App. filed May 28, 1911. A heater wire is wound on the container.



1,012,821.—Apparatus for Supplying Fluid Pressure.

1,012,724. INSULATOR SUPPORT; E. O. Sessions, Chicago, Ill. App. filed Jan. 3, 1910. Metal socket for a threaded wooden pin.

1,012,730. HIGH-TENSION MAGNETO-ELECTRIC MACHINE; F. R. Simms, London, England. App. filed Feb. 23, 1910. The condenser is held between the checks of the armature.

1,012,751. STORAGE-BATTERY SEPARATOR; W. Taylor, Philadelphia, Pa. App. filed July 8, 1911. Made from Sequoia sempervirens, or California redwood, which does not swell when wet.

1,012,752. STORAGE-BATTERY SEPARATOR; W. Taylor, Philadelphia, Pa. App. filed July 8, 1911. Made from Taxodium distichum, or American cypress.

1,012,753. ELECTRIC SWITCH; P. H. Thomas, East Orange, N. J. App. filed Feb. 10, 1904. Mercury switch with rotatable container.

1,012,780. SERVICE-METER SYSTEM; C. S. Winston, Chicago, Ill. App. filed Jan. 8, 1908. Central-energy telephone lines having three-conductor multiple jacks at the central office.

1,012,793. TELEPHONE-SERVICE METERING SYSTEM AND APPARATUS; G. Babcock, Rochester, N. Y. App. filed Jan. 22, 1910. Time and recording mechanism.

1,012,806. ELECTRIC SWITCH; F. Buchanan, Dayton, Ohio. App. filed Dec. 20, 1909. For car headlamps, multiple terminals.

1,012,808. METHOD OF PURIFYING WATER; W. B. Bull, Chicago, Ill. App. filed March 24, 1911. Electrolytic chlorine and iron treatment.

1,012,809. APPARATUS FOR PURIFYING WATER; W. B. Bull, Chicago, Ill. App. filed May 10, 1911. Electrolytic cell and separating chambers.

1,012,812. AUTOMATIC ALARM; C. Centoni, Chicago, Ill. App. filed April 19, 1909. For money and lock boxes.

1,012,821. APPARATUS FOR SUPPLYING FLUID PRESSURE; H. H. Cutler, Milwaukee, Wis. App. filed March 14, 1904. Automatic pressure regulation. See Patent No. 786,419; air-brake control.

1,012,828. STORAGE BATTERY; T. A. Edison, Llewellyn Park, West Orange, N. J. App. filed May 24, 1910. Insulating separator strip of rectangular cross-section.

1,012,852. ALARM FOR BOATS; C. L. Hoffman, Detroit, Mich. App. filed Jan. 28, 1910. Float-actuated leak indicator.

1,012,854. SOUND INTENSIFIER FOR TELEPHONES; W. Hoppie, Ogden, Utah. App. filed May 24, 1909. Plural diaphragms.

1,012,865. BURGLAR AND FIRE ALARM AND TELEPHONE SYSTEM; A. Köhler, Chicago, Ill. App. filed July 31, 1911. Central energy and alarm.

1,012,878. ELECTRIC BRAKE; J. N. Mahoney, Wilkinsburg, Pa. App. filed April 20, 1908. A controller for a system where the traction motor also actuates the brakes.

1,012,889. ART OF FORMING DIELECTRIC FILMS; R. D. Mershon, New York, N. Y. App. filed Jan. 5, 1910. The films are formed at a temperature above that at which they are to operate.

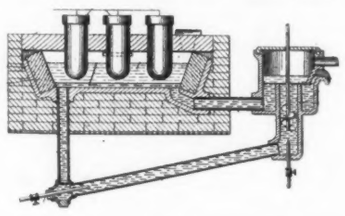
1,012,906. TELEGRAPH KEY; G. S. Perry, Dupont, Ga. App. filed Jan. 26, 1911. For sending an entire letter at one stroke.

1,012,908. STORAGE BATTERY; H. L. Peterson, J. M. Peterson and A. O. Retrum, Charles City, Ia., and Dawson, Minn. App. filed Feb. 7, 1911. A separator plate and an enveloping protector.

1,012,919. ANTISEPTIC TELEPHONE MOUTHPIECE; I. S. Rosenblatt, San Francisco, Cal. App. filed Feb. 28, 1911. Contains sterilized absorbent material.

1,012,934. ELECTRIC METAL-WORKING APPARATUS; E. Thomson, Swampscott, Mass. App. filed April 27, 1911. Welding machine having a plurality of pairs of welding jaws.

1,012,952. THERMOSTAT; G. P. Wild, Philadelphia, Pa. App. filed Dec. 2, 1910. Improvement on Patents Nos. 976,747 and 976,749 for controlling the charging of storage batteries.



13,343.—Electrolytic Process of Producing Nitrogen Compound.

1,012,953. THERMOSTAT; G. P. Wild, Philadelphia, Pa. App. filed March 8, 1911. Sealing in the conductors.

1,012,956. VIBRATOR FOR SIEVES; W. C. Woodland, Warren, Ohio. App. filed July 31, 1909. Reciprocating motor; for dredgers for sifting enameling material.

1,012,957. ADJUSTABLE PANELBOARD SUPPORT; W. Wurdack, St. Louis, Mo. App. filed Dec. 13, 1910. Improvement on Patent No. 929,812.

1,012,970. ATTACHMENT PLUG; R. B. Benjamin, Chicago, Ill. App. filed June 24, 1907. A base and a conducting sleeve.

1,012,971. ELECTRICAL CONDUCTOR GRIP; R. B. Benjamin, Chicago, Ill. App. filed Jan. 30, 1908. A spreader between the wires in a socket.

1,012,975. ATTACHMENT PLUG; R. S. Blake, Chicago, Ill. App. filed Sept. 2, 1910. Expansible screw thread for attachment without rotation.

1,013,029. ELECTRICAL BONDING DEVICE OR RAIL CONNECTOR; J. M. Lorenz, Chicago, Ill. App. filed Sept. 16, 1910. A pin round on one side and grooved on the other.

13,343 (Reissue). ELECTROLYTIC PROCESS OF PRODUCING NITROGEN COMPOUNDS; C. E. Acker, Ossining, N. Y. App. filed March 2, 1909. Original Patent No. 914,214; continuous. Forty-four claims.